THE

AËRONAUTICAL JOURNAL.

A Quarterly Illustrated Magazine devoted to all subjects connected with the Navigation of the Air.

EDITED FOR THE

COUNCIL OF THE AËRONAUTICAL SOCIETY OF GREAT BRITAIN

BY

BERTRAM G. COOPER, A.F.AË.S.

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Notices of the Aëronautical Society of Great Britain.

November Elections.

Members: Lord Edward Grosvenor, A. Graham Clark.
Foreign Member: Enrique Sanchis.
Associate Member: W. Lockwood Marsh.
Student: A. Ashton.

December Elections.

Members: J. L. Lake, Hartley B. Pratt, Cedric Lee.
Associate Members: Lieut. G. J. Malcolm, R.F.A., Hon. H. L. Pelham.
Student: G. T. R. Hill.

January Election.

Member: F. R. Harford.

Finance Committee.

Dr. A. P. Thurston has been appointed to serve on the above Committee in the place of Mr. Griffith Brewer, who has resigned therefrom.

Nominations for the Election of Council.

The last day for the acceptance of nominations for the Council will be Wednesday, 25th February next. Candidates for election must be nominated by two Voters and no more (see Rules 6-13). In the event of nominations being received ballot papers will be posted to Voters on 7th March, and must be returned by 12 noon on 18th March, 1914.

Annual General Meeting.

The Annual General Meeting of the Society will be held on Wednesday, March 18th, at 8.0 p.m., at the Royal United Service Institution, Whitehall, S.W. (Rule 39.)

The last day for the receipt by the Secretary of notice in writing from any Voter wishing to propose any subject for discussion at the Annual General Meeting will be the 3rd March.

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Wilbur Wright Memorial Fund.

The following shows the state of the Fund to the 31st December, 1913:—

1913. Credit:—

	£	s.	d.
Balance previously acknowledged	561	5	10
Interest to 11th December on deposit account ...	7	9	4
Interest on Aero-Educational Premiums Fund to 30th December, 1913	6	10	2
	£575	5	4
Dec. 10th.			
Investment by purchase of £550 Canada 4% Stock, 1940-60 New (G. Brewer and ors.) @ 96⅜, including bank commission and contract stamp	531	10	9
	£43	14	7

Prizes for Model Tests at the Northampton Polytechnic Institution.

The Society has donated the sum of £5 in prizes for a competition, organised in conjunction with the Kite and Model Aeroplane Association, of flying model aeroplanes, the final test in which will be to ascertain in a wind tunnel the best lift/drag ratio of the models. The competition will take place early this year.

Prizes for Aeronautical Students at Northampton Polytechnic Institution.

The Society has donated the sum of £5 to the Governing Body of the above Institution, which has been allocated as follows:—

Two class prizes of £2 and £1 respectively, and in addition a prize to the value of £2 for an essay upon a subject selected by the competitors from a list of subjects, of importance to aeronautics, approved by the Principal.

Meteorological Conference at Edinburgh, 1914.

On the initiative of the Scottish Meteorological Society, a Conference is being organised by a General Committee, under the Chairmanship of Dr. W. N. Shaw, Sc.D., LL.D., F.R.S., F.Aë.S. The Chairman of Council and the Secretary are representing the Society on this Committee. The date of opening has been fixed as Tuesday, September 8th, and the Conference will extend over the four following days, with an excursion on the Saturday to some place of scientific interest. Full details will be issued shortly in a preliminary circular.

Proposed Joint Committee with the Royal Meteorological Society.

It has long been felt that means should be taken to bring meteorologists and aeronauts into closer touch, as much work exists that can only be done by the two working in conjunction. Arrangements are now being discussed for the formation of a joint Committee of this Society and the Royal Meteorological Society, having as its primary object the collection of meteorological data from the point of view of aeronautics.

Library.

The Council desire to thank Dr. Alexander Graham Bell for a copy of "An Account of the Exercises on the Occasion of the Presentation of the Langley Medal and the Unveiling of the Langley Memorial Tablet, May 6, 1913," and also the U.S. Department of Agriculture, Weather Bureau, for a Weather Map of the Northern Hemisphere.

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THE FIRST MEETING of the FORTY-NINTH SESSION of the Aëronautical Society of Great Britain was held at the Royal United Service Institution, Whitehall, S.W., on Wednesday, 19th November, 1913, at 8.30 p.m. The Honourable Mr. Justice Atkin presided.

THE RIGHT TO FLY.

BY ROGER WALLACE, K.C.

On the last occasion I had the honour of attending a meeting of this Society the members were expressing their admiration of the great work done by the late Wilbur Wright. This consisted in first studying the known suggested theories governing the physical laws of flight, and then, after much patient labour, embodying the result of his reflections in the form of an aerial apparatus. Then at great personal risk, with his brother's aid, testing his apparatus as a glider until he was satisfied that a practical machine driven by power could be made; which he successfully accomplished and piloted with results well known to this Society.

To-night we have to consider many theories governing a different kind of law and suggest means by which they can be reduced to practical regulations. We have not the same opportunities as the physicists, no official laboratories or opportunities for making experimental tests, and have to leave this to the cumbersome machinery of the administrative authorities of the governing political powers.

The title which your Society has assigned me is one of a very general character, and it is evident that it would be impossible to do even a moderate measure of justice to the subject in the limited time assigned for the reading of this paper, but I understand by the communication from the Council that I am asked to deal specially with the question from an International point of view.

Anticipatory Laws and Codes.

It is somewhat remarkable that before any satisfactory progress was made in the development of aerial navigation many societies in various countries were formed for the consideration of the laws relating to aeronautics. Even in some countries complete codes have been drawn up and submitted to the responsible Ministers with a view to their adoption. Some of these societies are international, and have had a good many meetings, some dealing with the question purely from a juridical point of view. One of these societies has even gone so far into the details of the work as to have drawn up a clause for a proposed code to settle the question of the nationality of a child born while on board an aircraft, and it is curious that this is the longest clause in the whole proposed code. On the other hand, certain States have taken the matter in hand, and national laws have been promulgated in France, Belgium, Holland, and in Germany.

With regard to International Law a conference of the Powers took place, at the initiative of France, during 1909 till January, 1910, in Paris, and several meetings were held extending over many months. Very elaborate preparations

were made for these conferences, and the representatives of the Powers came prepared with answers to several questions which had been suggested by the French Minister of Foreign Affairs as a preliminary study. They had also an opportunity of knowing before the answers which the other Powers had sent, but in spite of these preparations and continued conversations and meetings the conference arrived at no result, and was adjourned *sine die*. From a careful study of such information as is accessible, it appears that the incapacity of the conference to arrive at any result was partly due to the different schools of thought arising from a theoretical consideration of the subject. These involve questions of very great importance, which will be dealt with later in this paper. While these are being settled it is essential that the matter should be looked at from a practical point of view.

Action of the International Aeronautical Federation.

All those intimately acquainted with aeronautics are aware that the international ruling authority among the various clubs and associations is the Federation Aeronautique Internationale. All the certified pilots in the world fly under certificates of this federation. This body, feeling that the law of aeronautics was a very important branch of their work, created in January, 1909, a "Commission de Droit Aeronautique" to confer with different Governments on questions of international, national, and private law. This Commission consists of representatives from each country, and who are respectively acquainted with the position from a naval, military, practical, and juridical aspect. Of course, it is evident that the bias of this Commission would naturally be for the benefit of aviation and aviators as a class, but still they have done their best to look at the matter with a view to the interest of the general public. At the last Statutory Conference held at the Hague, in August last, the report of the Commission was presented to the Federation and unanimously adopted. This report, after enumerating the eighteen countries which were represented, contained the following extract of the proceedings at the final meeting held at Brussels on 21st June, 1913.* :—

"Considering that certain States have taken, or are about to take, certain steps of a legal nature to limit aerial traffic, and even to place in jeopardy the life, not only of pilots and aeronauts, but of third parties; the Federation is of opinion that it is necessary to make international regulations for aerial traffic such as would safeguard the interests of individuals as well as the sovereignty and fiscal interests of the representative States. To guard against these grave inconveniences and dangers, the Commission applies respectfully to the Government of His Majesty the King of the Belgians to request the French Government, as the origin of the Conference Internationale de la Navigation Aerienne, which met at Paris in 1909, to communicate to the several Powers represented at that Conference the draft treaty which the International Commission had just adopted, and to urgently consider whether it is not advisable to again convoke a Conference of the Powers with a view to its examination and adoption."

The Government of His Majesty the King of the Belgians considered the request, out of deference to the wish of the Federation Aeronatique Internationale, and instructed its Minister at Paris to communicate to the French Government the draft treaty and the expression of opinion mentioned above. It now remains to be seen if the Conference of the Powers will again be summoned to resume its deliberations.

Before we deal with the draft treaty it is advisable to consider one or two questions.

* See Appendix B.

Should Aerial Warfare be banned?

The English representatives of the International Arbitration League propose that in the interest of peace aerial warfare be banned.

The same matter Fauchille proposed to l'Institut de Droit International in the following questions:—

(1) Où la guerre aérienne (supposée légitime) peut-elle avoir lieu?
(2) Doit-on admettre le droit des belligérants d'interdire, au-dessus de leur territoire, la circulation des aéronefs?

Monsieur Léon Bourgeois pointed out that these two problems involved the whole question of the supremacy and neutrality of the air, and expressed the opinion that laws governing the community of the nations in the air-space should be defined before attempts were made to dominate the air so as to prevent possession posing as having, as we say, nine-tenths of the law. All this, Mr. Millerand said, invoked the essential qualities of diplomacy, cautious consideration, tact, and prudence.

So far, in actual warfare, very little use has been made of aerial navigation. Napoleon tried and abandoned the use of balloons; he evidently considered that the difficulty of filling the balloons and transporting the apparatus for this purpose was not worth the trouble, more especially as France could have no monopoly of such a service, and possibly it would only enable other nations to cumber the strategy of which he was such a master. Later on the French had reason to bless the then only existing means of aerial transit when the free balloon was organised as an aerial post passing over the German lines carrying letters and despatches and even important personages, such as Gambetta, when he escaped to Tours from beleaguered Paris. This was so effectually done that Bismarck decided to consider their use as contrary to the rights of nations and aeronauts as spies.

Now that on sea and land aeroplanes are proving their capacity for efficiency, the air service is undoubtedly coming to the front, and is believed by some of the most important strategists and tacticians will prove the most preponderating factor in arriving at the equilibrium of European politics. The advocates of this view (the banning of the air in war) might well reconsider their attitude, for a little reflection might induce them to believe in the possibility of this new service proving the most effective weapon in bringing about the universal peace which they and all civilised nations desire. Peace Conferences and Congresses of Arbitration at the present moment do not seem of very great utility, except as in a general way preparing the minds of individuals for the future realisation of their projects. The inherent weakness of Courts of Arbitration is due to their inability to enforce their awards. In the distant future, intellectual, moral, or financial power may prove sufficient, but in the meantime some sufficiently effective force will be required.

This new arm of military and naval service will inevitably be tried in wars which are destined to take place before any effective organisation is established for the maintenance of international peace. It may be that after this trial an aerial international police may prove to be an efficient executive body to enforce the awards of the Courts of Arbitration when necessary. Then, perhaps, the ban on separate States might prove useful.

Attitude of Great Britain towards International Aeronautics.

There is another matter which perhaps you will allow me to deal with, and that is the attitude which this country is to adopt in dealing with the international question. It was openly stated at the conference in Brussels that Great Britain

was taking a very hostile attitude to the development of international aeronautics. This opinion was due to the new Act which has just been passed prohibiting the entrance of foreigners into England except at certain specified places on the coast line, these being very few in number and alleged to be on the most dangerous parts of the coast. It was felt that there was a desire to keep foreign aeronauts out of the country, and we were placed on a par with Roumania, who had forbidden any entry into the country. We were described as a retrograde and a savage nation. I am not sure that these epithets were entirely undeserved, and they certainly had the effect of securing a more accessible port of entry to foreigners into the United Kingdom. Germany, France, and other European States have till now been most liberal in their views as to the admission of foreigners, but I am afraid that, as we have set them a bad example, they may be likely to follow in our footsteps.

Restrictions in France.

Since writing this, a decree has been published in "Journal Officiel de la Republique Française" of the 25th October, 1913, which contains an order forbidding aeronauts to fly over certain zones, including all military camps, exercise and practise grounds, and even over whole "departments," if circumstances warrant; but exemption may be given for the development of aerial navigation for a period not exceeding one year to persons of French nationality. The Minister of War may grant the exemption after consultation with the Minister of the Interior in military matters and the Ministre de la Marine in case of naval matters. The authorisation to pass over these zones is given to foreign subjects in exceptional cases, and only for a period of six months, by the Minister of War, after consultation with the Ministre de l'Interieur, and, if required, by the Ministre de la Marine. The provision of the decree of the 21st November, 1911, has not been dispensed with, especially with regard to the transport of explosives, carrier pigeons, photographic apparatus, and wireless. Article 10 provides that, in case of publication of an order of mobilisation, flying is forbidden throughout the whole national territory, except in the case of aeronauts flying under naval and military administrations.

Aircraft and Civilisation.

Most advances in civilisation have been due to the improvement of the means of intercommunication—even savage tribes are now getting accustomed to allow expeditions to pass through their midst without molestation. Freedom of international railway communication, freedom of marine navigation, freedom of international cable communication and wireless transmission are marvellously developing the well-being of and amity amongst the nations of the globe, and it seems to me that it would be a mistake to do anything which would retard the growth of this rapid means of intercommunication, especially on the part of Great Britain, which has benefited most of all by like new developments. Our scattered Empire, and its centre most of all, demands the utmost rapidity in the means employed for transference of thought and material. We have profited in the past, but it seems that we were so blind as to the future that full consideration of our position was only brought about by panic caused by alleged ghostly appearances in the North Sea, instead of by deliberate reflection.

Our statesmen should perceive with open eyes that we can better protect ourselves by this new service against foreign invasion, that any rights which we give to foreigners for transit to our own country must be many times

compensated for by the rights which other nations will give us in return to fly over the far greater extent of their territories. So much for self-interest—which, I am afraid, although not a legitimate, is a very necessary argument at the present time.

If Cobden and those who preached Free Trade amongst nations had possessed any idea of the possibilities of the conquest of the air and its consequences, they would have had stronger arguments as to its future necessity.

Up to now, the main conception of boundaries has been those of a lateral description, but now we have to regard the question from the point of view of three dimensions of space, which is to some almost as difficult mentally as the mechanical evolutions of Pégoud in the air.

The Airspace has only one Boundary.

Every maritime ocean and every continent has its boundaries and limitations in all directions, but the aerial ocean has only one boundary, only one frontier, and that is the surface of the globe which it imprisons in its embrace. It requires, and has in fact, no lateral support beyond its own, and, as far as we know, no definite external restraining force. This description, it will be observed, applies not only to the air as an element, but to the air space containing the element.

We should look on that element as one, the property of no nation, of no individual, but as common to all nations and individuals, subject to certain rights already acquired by and inherently essential to States and individuals.

Human flight is accomplishing a peaceful revolution in the views of mankind, and in making laws for aerial navigation, and more especially to those pertaining to Customs, it is incumbent on the law-makers to endeavour to establish simple and practical rules which, while safeguarding these rights acquired by the States and by the inhabitants of the land, will assure the free development and untrammelled expansion of this latest aid to civilisation and universal peace. An agreement would soon be come to if the States will only bear in mind the laudable maxim of Montesquieu: "Le droit des gens est naturellement fondé sur ce principe que les diverse nations doivent se faire dans la paix le plus de bien possible et dans la guerre le moins de mal possible."

Of course, the draft treaty which I mentioned earlier has been framed, not as if the Commission had a free hand to draft an International Law and Regulations, but to arrive for the moment at a solution which can be adopted by the different Powers without offending the susceptibilities of any nation. No doubt in thus treating the matter those who take the most extreme view of the liberty of aeronauts to travel at their own will, at all times and in all directions without let or hindrance, have been disappointed at the modesty and meagreness of this draft treaty. There is a good deal, however, to be said from their point of view, and, indeed, theoretical questions were always in the minds of those who met together to frame these regulations. This being so, I think it is well that we should consider briefly in this paper the opinions of the different theorists.

Theories as to the Freedom of the Air.

Mr. Haseltine, in his "The Law of the Air," says:—"It is universally admitted that the air space over the high seas and over unoccupied territory is absolutely free to all States and persons desiring to use it; and we may, therefore, for the present, leave this air space entirely out of account."

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I agree to this statement, with the following qualification: International lawyers and the Powers have fixed the maritime limit at a distance of three miles from the coast, so that a State, according to this regulation, would have no sovereign right, or right of any kind, which would extend its aerial jurisdiction beyond the three mile limit. Now, the experiments of McLean, Samson, Curtiss, Hawker, and others have shown that hydro-aeroplanes can easily be manœuvred from warships. From their decks outside the neutral maritime belt, planes could easily be launched in the air and pass over the adjacent territory in a few minutes. Does this three mile limit aerial belt give sufficient protection for any nation suddenly attacked? The facts speak against this, and the Powers will have to consider the grant to nations of another limit giving them aerial rights, national easements, or whatever they may be termed, so as to ensure them sufficient protection of the nature accorded in the case of the maritime limit.

So far as I am aware, this is the first time this question has been raised, and no limit has been suggested. Twenty miles would hardly give sufficient security. The position of Great Britain and France at the Straits of Dover would be difficult for diplomatists to settle if this limit were fixed upon.

As far as I can gather, there are several theories as to the right to fly. I have omitted from these definitions such terms as "the liberty of the air," of which I do not understand the meaning.

(1) That the air space is free to the use of all without restriction of any kind, and that over it no dominion, sovereign or otherwise, can be imposed. (*Res communis omnium.*)

(2) That the air space is free to all, except that aerial zones are already sovereignly possessed by States over the surface of the land ruled by them.

(3) That all the air space over the land and maritime belt adjacent is already within the possession of the existing sovereign Powers, subject to the right of innocent passage, and is only free over the remainder of the seas and maritime oceans and unoccupied land and deserts. (*Qui dominus est soli dominus est coeli et inferorum.*)

(4) That the air space over the globe is free to the use of the aircraft of all nations, and is only subject to such rights as are required by the subjacent Powers for their respective protection against attack, espionage, infection, infringement of fiscal rights, and any further danger to the life and property of their subjects.

In my view, Nos. 1 and 2 are impracticable, and Nos. 3 and 4, when practical regulations are framed, lead to the same results; but I suggest that No. 4 is the most logical theory, taking everything into consideration. For No. 1 we must wait for the millennium. In my opinion, No. 2 is rendered abortive by the adoption of the horizontal zone theory.

M. Fauchille first fixed the vertical limit of the free horizontal zone at a vertical distance of 1,500 metres from the surface, but subsequently agreed with Captain Ferber's 500 metre proposal. Rollin places the limit at 300 metres, and others at various other limits. In attempting to give an innocent right of passage, the advocates of this system, contrary to their intention, only limit the facilities required. Why make the foreign aeronaut fly at all times at a prescribed height when the State can be protected by other regulations, such as those proposed by the Federation Aeronautique Internationale, with much more security to itself and much greater control over the traffic?

No. 3 in effect affirms the sovereign power of the State, but grants to aircraft a limited right of passage through the air space, while No. 4 claims the freedom of aerial circulation, subject to the right of subjacent States to secure their conservation by certain rights.

Perhaps the best way to accentuate the difference between No. 3 and No. 4 is that one gives the chief place in the definition to the liberty of aerial circulation and the other to the sovereignty of the State over the air space above its land.

It is by adopting the spirit of Nos. 3 and 4 that the Commission of the Federation Aeronautique Internationale, I believe, arrived at the measures described in the draft treaty.* Later, I shall state these principles in different words.

At the Paris Conference of the International Law Association, M. Desouches and M. Fauchille may be taken to represent generally the view of the freedom of intercommunication, and Mr. Harold Haseltine the view of the sovereign ownership of the State. In opening the discussion in Paris, M. Desouches, before commencing his paper, "La Liberté de l'Air," stated that he had just returned from the meeting at Brussels, at which he was one of the delegates of the French Aero Club, to the Commission Permanente de Droit Aerien de la Federation Aeronautique Internationale. He said: "This Federation consists of an association of all the Aero Clubs, and they have an almost official situation, because of the reports and communications which they hold almost daily with the Government Departments of their respective countries, and they also exercise a great influence over their respective Governments, because of their special knowledge. Although, as will presently be seen, the Aero Club of France and similar institutions in that country hold very strong views as to the necessity of absolutely free communication through the air, it is one of the consenting parties to the report and draft treaty hereinafter published." The French club in all its publications proclaims the national or international freedom of all aerial routes, not as the manifestation of sentiment, but as the affirmation of an inherent necessity to the various modes of aerial circulation through space, and in effect they consider the air and atmosphere to be an immense ocean, without bounds of continuity, below which stretch all parts of the earth and all the seas, and that, therefore, it is impossible to impose to its use any geographical limit or boundaries. It suggests that States which have the tendency to attribute any certain nationality to the air or that portion of the air which is above their territory should renounce their pretensions as soon as they recognise that the terrestrial globe is "sous la domination de la puissance des dimensions de l'ocean aérien." M. Desouches puts it thus:—It is not presumptuous to say that this power (l'ocean aérien) secures to all those who are engaged in aerial navigation an independence which effectively permits them to easily withdraw themselves from the application of all theoretical regulations meant to restrain their right to the free use of the air. He contends that aeronauts know best how to choose their own route, that they alone are qualified to settle the altitude which they adjudge to be the best, and at what angle and in what direction they must fly so as to modify their course according to the direction and strength of the winds. And he further affirms that it is practically impossible to prevent aeronauts crossing boundaries. An aerial police would be sure soon to show its want of power, as air vessels could fly into the clouds and travel at an altitude at which it would be impossible to identify them. For the same reason it would be impossible to oblige them to descend at the frontier or other specified places. That any such regulation would be ineffective, owing to the difficulty of navigating the air during fogs, and because it might be quite impossible in the case of an accident to the machinery to arrive at the landing place fixed upon by the Government—just, in fact, as a ship for various reasons is bound to change its direction at sea or to seek another port when the one fixed on cannot be entered without danger. They also contend that modern thought would not allow of enforcement of any Draconian punishment on the descent of the aeronaut infringing regulations, and they say that the faculty of travelling in complete independency the vast aerial ocean which it is impossible to limit and to control

* See Appendix C.

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by any police is not inappropriately styled "La Liberté de l'Air." These premises being admitted, legislation, both international and private, would be bound to be very much in favour of the aviator. They assume that airships ought to have the same rights accorded to them in the air that ships have at sea and vehicles on the roads, that there are no boundaries except the surface of the earth, and consequently an airship would only be limited by the horizontal surface of the earth, in the same way as a sea ship is by the coast line. The usual geographical frontiers have no meaning as far as aeronauts are concerned, therefore, in times of peace the State should have no jurisdiction over an aeroplane until the moment of its landing, and in times of war only so far as they could be fired at from below.

Proceedings of the International Commission at Brussels.

When the International Commission met at Brussels, under the presidency of Prince Bonaparte, they had the advantage of the persons of experience in aeronautics and jurists who had attended most of the other conferences held, not only by the Aero Clubs and Associations in their various respective countries, but also the opinions of other societies which looked at the matter from the juridical point of view, such as those held by the International Law Society and the "Comite Juridique International de l'Aviation."

The Commission have also to thank the Belgian Aero Club and its President, Mr. Jacobs, for the care which they took in making all the arrangements necessary for holding these conferences—a service which was duly afterwards honoured by the vote of the Federation itself in full conference when the work of this section was adopted.

After a great deal of discussion on the principles and theories which should govern the aerial laws, both lawyers and practical men came to the conclusion that it would be inadvisable to discuss the question of sovereignty, because in time of war the Powers would act as they thought best in their own interest; hence Article 2 of the proposed treaty provides—"That every signatory State could at any time denounce the treaty." Generally speaking, as far as I can gauge the views of the members of the Commission, their decisions were based upon a compromise derived from a blending of three principles:—

(1) The principle of sovereignty of the State which has its birth in the nature of national independency and which creates the obligation of those who rule the State to take precautions and to furnish means of self-defence embracing all the necessary machinery for national and individual safety and security.

(2) The principle of the so-called "Liberté de l'Air," which guarantees the independence of aerial flight and assures impunity against the infraction of published regulations so long as it is impossible to identify the aeronaut and so long as he has not made a descent.

(3) The principle of freedom of circulation, which in our days places so many facilities at the disposal of the individual for enjoying the right to go from one country to another without being unduly inconvenienced by police and Customs regulations.

All the time, however, there was an undercurrent of feeling that because of the internationality of the air it could not be the exclusive property of any State and that no State could exercise its jurisdiction beyond such a point as it could establish an effective police, and that, therefore, the States were obliged to sanction this condition of affairs by making international regulations in common; hence the necessity for providing for national and international registers,

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so that aircraft could be easily identified, in order to render them subject to all penalties arising from breach of regulations, whether national or international.

Rules for Aerial Traffic.

The Commission, so as to avoid accidents arising from the new mode of locomotion, has endeavoured in as simple a fashion as possible to unify the necessary rules for aerial traffic, having before them the French regulations in the decree promulgated on 25th November, 1911, as a draft.

These rules are very simple, and I have asked Mr. Griffith Brewer, who attended the Sub-Commission, to give an explanation during the discussion.

After the last Conference the question of Customs was considered at very great length, and hopes were expressed that an efficacious solution to many important problems had been found. These will be dealt with later.

The word "aéronef" (aircraft) has been adopted by the Commission to include all apparatus adapted for aerial navigation, such as aeroplanes, dirigibles, and free balloons :—

The Draft Treaty.

Section 1. (Titre 1.) The aircraft, which is only an instrument, has not been exclusively dealt with, as in the proposed codes formulated by other societies; but the pilot is specially held in view, as in fact the soul exercising the responsibility and control of the machine. From this pilot certain formalities are required so as to guarantee his fitness for the post, and also the identity of the aircraft which he directs.

Section 2. (Titre 2.) Provides for the security of aerial traffic by strict regulations; regulations as to the lights of dirigible balloons, aeroplanes, and free balloons; the employment of phonetic signals in the times of fog, haze, and snow. It also provides rules for signals of landing and of distance, and regulates the proper manœuvring of aircraft. These I have also asked Mr Griffith Brewer to deal with during the discussion.

Section 3. (Titre 3.) When dealing with this section it should be remembered that the Federation Aeronautique Internationale exercises two functions—one sportive, which deals, for example, with questions of tourism; the other more serious, which deals with the transportation of merchandise.

Therefore, Chapter I. is based on the adoption of an international triptych similar to that now in general use as far as automobile clubs are concerned, which practically is employed in all countries, and regulates the international circulation of motors. Under these circumstances, Articles 19, 20, and 21 are very simple, and only apply to a temporary stay in the country—that is, the aircraft arrives, comes to land, and then returns to its own or proceeds to another country. This is provided for by the deposit of security—that is, a certain sum of money covering the value of the aircraft in the country of origin. Originally this was of great benefit to motor-cars especially in the early days, and now is universally adopted, and works very smoothly.

For many years, as Chairman of the Royal Automobile Club, I had to sign all these triptychs for automobiles travelling abroad, but of course now the number is so enormous that it has to be done by means of stamps, not only at the club, but at the other associations now granted the privilege. I think many people will be surprised to know of the enormous sums that are thus deposited, and I do not suppose that the banks are allowed to have the money on deposit without paying a proper interest.

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As to personal baggage and belongings of the pilot or passenger, they are dealt with in the same manner as is adopted with regard to travellers on the frontiers by land or sea.

Customs are dealt with under Chapter II. of this section—Transport and Merchandise—which was compiled after consultation with and under the advice of the Customs authorities of the different countries.

To arrive at its destination, an aircraft should be allowed to travel by day and by night by the nearest possible route to its destination, so that the pilot may use his compass to the best advantage; any deviation or obligatory stop should only be imposed by law when there is urgent necessity so to do, as any such are very detrimental and unsuited to the industry.

How, then, are Customs arrangements to be made? Of course, the authorities would choose in the first instance the simple rule of making descent at the frontier obligatory. This is comparatively easily managed with existing traffic, but it would be difficult to make arrangements all along the frontier line for the establishment of Customs patrols to enforce obedience in the event of the infringement of aerial regulations. It would be too costly, because of the many aerial routes and the difficulty of observation in times of darkness, fogs, mists, and banks of clouds. On the assumption that the only real frontier is the surface of the earth, the "Commission Internationale de Droit" of the Federation Aeronautique Internationale has devised means to provide proper protection against infraction of Customs regulations.

These rules may be generally described as follows:—Sections 1 and 2 having been complied with as to the registration of aircraft and the certificate of the pilot, etc., documents have to be filled in and Customs formalities complied with so as to afford the necessary guarantees. You will find these in Appendix D.

On the registration of an aircraft the owner has the right to ask for a "permit to travel" (*permission de circuler*) from the authorised authority, without which in his possession no pilot has any right to navigate. You will observe that this provides for a specification of the motor (if any) and the apparatus on board, also for particulars of its registration. The name and nationality of the owner and pilot is stated therein, and can be filled in for free balloons, dirigibles, aeroplanes, and hydroaeroplanes. This is all the aircraft requires so long as it stays in the country of issue. When the pilot has the intention of leaving the country and crossing a frontier he must make a declaration to the nearest fiscal authority of the nature and quantity of the goods to be transported, as well as personal luggage or of the absence of such luggage or merchandise. These particulars are entered in a register, the pilot then gives up his "permit to travel," or another document called "Laisser passer" (as explained hereafter), and receives in exchange the "Customs Bulletin," on which is entered:—

(1) The nationality of the airship.
(2) Particulars of the registration.
(3) Particulars of passengers, goods and baggage.
(4) The date and place of departure and destination.

On arrival at his destination the pilot must forthwith present to the proper fiscal authority his bulletin and pay the duties, etc. Particulars of these are entered in a register. This handing in of the bulletin is an obligation required from all aircraft passing from one country to another and when re-entering its own country, whether or no passengers and merchandise be carried.

While in the country the aircraft may be at any time inspected by local fiscal agents.

In the foreign country the pilot receives from the agent the document "Laisser Passer" specifying:—

(1) That fiscal rights have been complied with.
(2) Name, nationality of aircraft and of pilot.
(3) Registration and specifications as before.

This "Laisser Passer" is valid during all the stay of the aircraft in the foreign country and on leaving has to be given up and replaced by the "Bulletin de Douane" to allow of admission into any other jurisdiction. Finally, when the aircraft wishes to return to its native country, if the owner and pilot so desire, a new "permit to travel" is issued and must be carried on board while in its own country till replaced by a fresh "Bulletin de Douane." So that either of these documents must be produced in the country of origin, or in the case of a foreign country, either "Laisser Passer" or the "Bulletin de Douane."

The authorities of each country fix the penalties for infraction of its laws or for the carrying of contraband, so that the effect is exactly the same as if each State was the sovereign aerial authority within its territorial boundaries.

This draft, having the sanction of the body representing all the certified pilots of the world, shows the extreme moderation of the claim of the Pioneers of Flight as compared with the theoretical contentions of the many jurists and even of representatives of the Powers at the Conference of 1910, so far as Customs are concerned, because the owner and pilot are each made responsible and have to be furnished independently with their respective certificates. This is mainly due to the adoption of the three documents which for convenience has been called the triptych. As free balloons are at the mercy of the winds all those questions which are regulated by the will of the owner and pilot are considered to be inapplicable.

You will find these provisions in the Appendix C. embodied in the Draft Treaty, which is in French (adopted by the Federation as the international language of aviation) and I shall be glad to answer any questions which may be put to me as to their meaning.

I pass now to another International question:—

The Use of Explosives and Projectiles from Balloons and Airships.

The Hague Conference in 1899 passed a vote, which was accepted by all the Powers, prohibiting aircraft from discharging projectiles or explosives, leaving them free to be used for intelligence and other purposes, but the term of the prohibition was limited to five years from that date and expired in 1905. This declaration was again passed at the second Hague Conference, 1907, the period of five years being changed and extended until the termination of the third Peace Conference (1914). However, a large majority of the nations failed to give their assent, among whom were Germany, France, and Italy; it is now only binding on the contracting Powers, among whom are Great Britain and Austria-Hungary. According to the Convention the terms are only enforceable amongst the contracting Powers, so that in a war between Germany and Great Britain the declaration would not be in force, and if, say, Great Britain and Austria (contracting parties) were at war and joined by allies from among the non-contracting Powers, they would be freed from their obligations. Practically then this regulation is a dead letter and could not be enforced, so that in a general European war nations would be free to use aircraft in any manner they please, except against undefended places, which by another article are protected from any bombardment

whatsoever. The complete change in the position of the Powers was due to the increased facilities for dealing with aerial navigation, the former pious opinions having been expressed when the matter was really one of indifference or of very little practical account.

Article 25 of the regulations for the Law of War on Land was in 1907 extended by the addition of the words "by any means whatever," so as to include the dropping of explosives by airships or aeroplanes.

Now as it is proposed that guns and projectiles should be used to attack aeroplanes, and as no doubt there will be magazines and arrangements for this purpose in large open towns, it will most likely be held that they are places fortified against aeronauts. It would be better then to leave unfortified towns undefended as regards aircraft, as it appears to me that in that event they would suffer much less injury.

I have already alluded to the use of balloons at the siege of Paris and the irritation which was caused by the threatened treatment of aeronauts as spies by Bismarck, and it is pleasing to say that this question was settled at the Hague Conference of 1907, following the decisions at Brussels in 1874 and at the Hague in 1899. Of course, balloonists have otherwise so to conduct themselves as not to act clandestinely or on false pretences. In order that there should be no doubt about the matter it was stated that to this class belongs the case of individuals sent in balloons to deliver despatches to maintain communication with the various parts of an army or of a territory. The danger would then be that they might be treated as prisoners of war.

Freedom Accorded to Passage of "Wireless" Waves—Suggested Analogy.

One of the most important arguments that the advocates of the principle—freedom in aerial circulation—can advance is that already in regard to wireless telegraphy the principle that the air is free to the use or passage of Hertzian waves has been adopted.

Mr. Haseltine evidently feels in his advocacy of the principle of "national sovereignty in the air" that this advocacy in the direction of freedom requires to be rebutted, and his only argument is that there is an important distinction between Hertzian waves and aircraft. As regards their relation to the land and air space, he says that the passage of Hertzian waves results in no danger to the land and no interference with anything in the air space, whereas the passage through air space (of great and substantial bodies) results in danger to property and persons below. I do not think that his argument is very strong, because the size of the aeroplane is not of such a large and substantial nature as Mr. Haseltine seems to believe. The popular idea is that from every one of these airships continual jettisons of objectionable matter will be poured on the surface of the earth and that inhabitants will be in constant dread of the vessel itself descending and injuring persons on the land. Now when the matter is looked into the persons on land who have been killed by the fall of aeroplanes have been so few as to be practically negligible and there is practically no complaint of jettison from an aeroplane, in fact it is well known that even when from a dirigible or free balloon you empty a bag of ballast practically none of its contents ever reaches the earth except in such finely divided state as to be undiscernible. I do not say that the passage of Hertzian waves through the atmosphere does any harm, but certainly the passage of an aeroplane through the atmosphere equally does no harm. If big vessels such as the Zeppelin are to be used they will only be used if they are successful and do not bring about these dire results which

Mr. Haseltine anticipates. All rights proposed to be governed are subject to the power of the owner of property and the territorial state to prevent the passage of air waves if such passage does harm to the landowner's or State's legitimate interest, and it seems to me that no more harm could result to the individual or the State by the use of airships than is likely to result in the disturbance of wire telephones and telegraphs by the passage of Hertzian waves.

By the Berlin Convention an international office was established for wireless, similar to that already existing for post and telegraphs at Berne. The duty of this office is to prepare for any alterations of the Convention which might be necessitated because of the advance of the art and also to collect all information and do administrative work as may be required in the joint interest of wireless telegraphy.

It is impossible in this paper to go into the various work that has been done and the decisions that have been arrived at so far on the positions of neutrals in time of war in regard to wireless telegraphy, jettisons and other matters; but I do think that the time is ripe for the establishment of such an international office, and this could easily be done by adoption of the organisation of the Federation Aeronautique Internationale, which is in touch with every certified pilot throughout the world. Of course alterations would have to be made in the regulations and constitution of the Federation, but this would be a very easy matter to thoroughly accomplish without delay.

National and Private Law.

Personally, I am not in favour of legislation at the present time, I think a great deal more study of the question and further experimenting with a view to safety of aircraft is required before the time is ripe for legislation. What is really required is for the State to give proper grants to make these tests. Although the Government have done good work in aiding the National Physical Laboratory, the State has practically done nothing to really assist airmen in their work. The apparatus for testing materials at the laboratory at Bushey is becoming efficient and is at times of great help, and the officials are always kind and do the best that can be done with the limited funds at their disposal. To gather together a number of personages with great names to meet once or twice a year to make a lengthy report, although very interesting and valuable in the future, does little to give practical help to the present craftsmen in the art or to arrive at any new types in aeronautical machines. Considering many men are so interested in the subject as not only to devote their time but their lives to the achievement of the conquest of the air, a Government grant of a few hundred thousand pounds would be a mere trifle, and properly distributed would be far more productive in the directions of advancement in the skill of flying and improvements in the machines.

Restrictive Legislation.

The only laws that have been passed up to the present have been of a restrictive kind. I am afraid if an immediate legislation were brought about the law-makers would not be sufficiently accustomed to the sight of aeroplanes and would look at the subject on which they had to legislate very much in the same way that horses looked on motor cars in the early days. Of course, the present attitude of the equine race is quite different. Not so long ago you remember it was thought necessary to have further legislation in connection with the motor car traffic. The earlier legislation had stopped the develop-

ment for nearly 100 years. To my mind it would have been quite sufficient to have abolished the old Act and have relied on the Highway Act, 1835 (5 and 6 William IV. c. 50). The principal thing that the new legislation did was to encourage the idea that as long as you were going 20 miles an hour you could do no harm, and that the moment you went over it you became a general danger to the public, even when you were going along the roads with nobody in sight or, in fact, nobody near with the exception of the gentleman placed in covert for the purpose of making observations. There would have been, I believe, less accidents if the speed limit had never been adopted. The fact is the House of Lords recognised this and passed the Bill without the speed limit, and it was only when it came down to the House of Commons that this limit was inserted. Fortunately at present there is no law which forbids you to fly in general, and certainly no speed limit, and the only good that the law can do would be to say that the airman has a right to be in the air with his machine provided he does no appreciable harm to anyone else—in other words, that the State should acquire by Statute the right to govern air traffic so that the aviator could fly not on sufferance but of right.

Rights of Landowners.

The belief has been handed down from the times of the Romans that the exclusive right of property in the air is vested in the owner of the surface of the land below—" cuius est solum eius est usque ad coelum "—and the greatest English writers, such as Coke and Blackstone, have given their adherence to this doctrine in the widest sense, namely, that the landowner owns the column of air above his land to the sky. Of course nobody can doubt that he should have the use of so much of the aerial space above his land as may be necessary for the construction of buildings or for works, but I imagine that this definition resulted from imperfect knowledge and from want of prophetic vision. Had lawyers but foreseen the use to which the air would be put as a means of communication they could not have been likely to appear to accord an absolute property to the landowners in the whole column of air above the surface of the land—they would merely have given an easement to use so much of the space and abstract so much of the fluid as might be essential to the uninterrupted enjoyment of their property in the freehold of the land. Because there have been a series of legal maxims arrived at without due appreciation of facts, materially substantial; these not being present to the minds of the creators of these maxims and even though these maxims have been followed by the greatest lawyers who were also ignorant of the circumstances; I fail to see why we should not adopt the view that the freeholder of the land has merely an easement. If so, no new law would be necessary. Of course the matter would have to be fought out, and I do not anticipate that any decision below the House of Lords would be accepted, and then only because there is no higher Court to go to.

The German Civil Code establishes the right of the owner to the entire air space above the surface of the land and to all below; but rather inconsistently it goes on to enact immediately afterwards that the landowner cannot exclude persons from the use of the air space above his land unless he has an interest in so doing.

The Swiss Code enunciates a similar principle. It appears to me that this Code gives to anybody the right to use the column of air provided he does not interfere with the interests of the owner of the land who possesses the freehold. At English common law the owner of land in England is held at present by the Courts to own the column of air space to the skies, but to have no effective right to prevent an aviator flying through that column when no, or next to no, damage is done to the landowner on the principle

of "De minimis non curat lex." This is a good way out of the difficulty, but merely a makeshift; clearly if judges wish from case-made law to build up a consistent theory they must start with the principle of easement and not as Mr. Haseltine suggests of absolute ownership. Lord Ellenborough had evidently great doubts about the matter, as is seen from his judgment in Pickering v. Rudd (1815) on the question of a projection overhanging a plaintiff's garden. In his judgment he says that if an action for trespass could be brought in such a case it would follow that an aeronaut would be liable to an action on the suit of the occupier of every field over which his balloon passed in the course of his voyage. Other eminent judges have commented on this case, but the most interesting is that of Lord Blackburn in Kenyon v. Hart when he said:—"I understand the good sense of Lord Ellenborough's view; but not the legal reason for it." As the legal reason in Lord Blackburn's mind, as far as I can discover in the various judgments and expressions of opinion, is founded upon the well known maxims, which are merely assumptions, I do not see why the Court should be bound now that the means by which the air can be used are becoming known. Why cannot a new definition of the right be arrived at even though new maxims have to be invented more consistent with actual conditions? There has been no general grant of this freehold, and there certainly has been no sufficient occupation of the alleged property to have ever given the freeholder of the land the dominion which he has been alleged to possess. On my first consideration of this matter I held the view of which Mr. Haseltine is so able an advocate, which I may say is the view of English lawyers almost without exception; but when we are inaugurating a new era of communication which will eventually be the most comfortable, the most rapid and the most efficient in many respects of all, why should judges be trammelled by the authors and decisions of the past when they can perfectly and consistently adopt a new and better theory.

The Home Office kindly let me see a draft of the proposed Bill for regulating traffic in this country, but I congratulate them on keeping it back until the industry has had a chance of developing. If legislation is commenced, the first thing that would have to be done would be to take away the alleged right from the landowners.

When revolving in my mind the best fashion of framing the concluding paragraphs of this somewhat discursive dissertation I took up the morning paper and read Mr. Winston Churchill's speech at the Lord Mayor's banquet. The matter was solved. After admitting that we had been tardy in recognising the merits of aviation, he said:—

> "I would venture to submit to this great company assembled that the enduring safety of this country will not be maintained by force of arms unless over the whole sphere of aerial development we are able to make ourselves the first nation. Many difficulties have to be overcome. Other countries have started sooner. The native genius of France, the indomitable perseverance of Germany, have produced results which we at present cannot equal. In order to achieve the position which is necessary the War Office and the Admiralty will have to work together, as they are now working, in the closest intimacy and co-operation. In order to achieve that position you will have to make up your minds to spend year after year your money, and month after month to pay your toll in precious lives. The keenest eye, the surest hand, the most undaunted heart, must be offered and risked and sacrificed in order that we may attain—as we shall undoubtedly attain—that command and perfection in aerial warfare which will be an indispensable element, not only in naval strength, but in national security. (Loud cheers.) *The Times*, 11th November, 1913.

XUM

I remember at Hendon when Mr. McKenna, then Lord of the Admiralty, made his first ascent, Mr. Asquith tried to dissuade him, being loth to risk his loss, no doubt thinking that some of his legal colleagues would soon take their flight into more elevated and more permanent positions. However, I finally persuaded Mr. McKenna, and Mr. Churchill stood by pondering till the former started his flight and watched most critically until the safe return of the aeroplane.

Who knows? It may be on that day Mr. Churchill made up his mind to change, at no distant date, positions with Mr. McKenna, not only as to a seat in the aeroplane but also in his office.

After such a strong declaration we need not fear that the interests of aviation will be longer neglected; but confidently hope that they will be taken up in such a spirit as to show other nations that we do not dread but welcome its coming amongst us as a means of bringing about for Great Britain greater national safety and still more friendly international intercourse.

APPENDIX A.

RAPPORT DE LA COMMISSION INTERNATIONALE DE DROIT AERONAUTIQUE.

La Commission Internationale du Droit Aéronautique s'est réunie à Bruxelles, sous la présidence du prince Roland Bonaparte, assisté de M. Wallace, président de la Commission, les 17, 18 et 19 mai 1912.

Assistaient aux séances les délégués des pays suivants: Allemagne, Autriche, Belgique, Egypte, Etats-Unis, France, Grande-Bretagne, Hongrie, Norvège, Pas-Bas, République Argentine, Suède et Suisse, treize nations.

Les procès-verbaux des séances actuellement à l'impression seront envoyes incessamment aux intéressés.

Nous avons l'honneur de vous soumettre un rapport succinct concernant le projet de traité réglementant la circulation aérienne internationale, qui a fait l'objet principal des travaux de la commission.

RAPPORT CONCERNANT LE PROJET DE TRAITE REGLEMENTANT LA CIRCULATION AERIENNE INTERNATIONALE.

La Commission Internationale du Droit Aéronatique a élaboré le présent projet de traité réglementant la circulation aérienne internationale. Ce projet n'est pas encore complet car il ne comprend, outre un titre préliminaire, qu'un titre établissant les conditions de la circulation et un titre réglementant la circulation. Il faudra que le projet de traité soit nécessairement complété notammente par des dispositions relatives à la douane. La Commission y pourvoira ultérieurement.

Tel qu'il a été arrêté par une assemblée de juristes spécialisés dans les questions du Droit Aérien et de techniciens dont l'aide fut précieuse autant qu'indispensable, le projet peut être considéré comme un travail définitif.

La clarté et la concision des textes arrêtés, la simplification d'une réglementation que certaines législations positives avaient rendu compliquée, la sobriété des articles votés en font un projet d'application surtout pratique.

Les théories pures ont été écartées du projet qui s'est attaché surtout à édicter des règles aisément applicables tout en respectant dans la mesure la plus large la liberté de l'air qui est dans les vœux de tous les pays, dans la mesure où celle-ci est compatible avec leurs droits de souveraineté.

Les auteurs ont jugé inutile de trancher des questions de droit public et de droit privé que seules les nations peuvent souverainement trancher. Le présent traité international n'a pas l'ambition de trancher des difficultés de théorie ou de droit pur: il constitue une réglementation simple et sommaire quoique suffisante de la circulation internationale aérienne.

Le titre préliminaire ne contient que quelques indications générales qui devront faire corps avec le protocole diplomatique que les représentants des différents états signataires du traité arrêteront. Les trois articles qu'il contient ne figurent donc dans le projet qu'à titre d'indication générale.

Le titre I se borne à établir dans quelles conditions les pilotes seront admis à survoler les territoires des états signataires du traité. Son article 4 qui est le plus important du traité résume ces conditions. Ce titre et cet article devront nécessairement être complétés par les dispositions spéciales relatives aux prescriptions en matière douanière.

Le titre II réglementant la circulation a simplifié autant qu'il était possible les règles concernant les feux, les signaux phoniques et autres, et l'emploi du lest. Les règles de route et de manœuvre, inspirés souvent par les prescriptions du droit maritime, ont été soigneusement étudiées par les techniciens et le résultat fructueux des travaux d'une sous-commission spéciale ont assuré l'adoption d'un texte dont on appréciera à la fois la brièveté et la clarté.

Une sous-commission chargée d'élaborer un avant-projet de titre réglementant la question douanière n'a pas encore terminé ses travaux. Dès que cet avant-projet sera arrêté la Commission internationale du droit aéronatique pourra le mettre en discussion aux fins d'arrêter les textes définitifs qui formeront le titre III du présent projet.

Le secrétaire, E. LAUDE.

Le secrétaire-rapporteur,
L. HENNEBICQ.

FEDÈRATION AÉRONAUTIQUE INTERNATIONALE.

APPENDIX B.

Commission du Droit Aéronautique, Bruxelles, Avenue Marnix, 6.

EXTRAIT DU PROCÈS-VERBAL

DE LA SÉANCE DE CLOTURE

de la Commission Internationale du Droit Aéronautique.

BRUXELLES, 21 Juin, 1913.

"La Fédération Aéronautique Internationale, réunissant dix-huit pays (Allemagne, Autriche, Belgique, Danemark, Egypte, Espagne, Etats-Unis, France, Grande-Bretagne, Hongrie, Italie, Norvège, Pays-Bas, Portugal, République Argentine, Russie, Suède et Suisse), représentée par sa Commission Internationale du Droit aéronatique, réunie à Bruxelles les 17 et 18 mai 1912, et les 20 et 21 juin 1913:

BRUXELLES LES 17 ET 18 MAI 1912, ET LES 20 ET 21 JUIN 1913:

"Considérant que certains Etats ont pris ou sont sur le point de prendre diverses dispositions légales de nature à entraver la circulation aérienne et même mettre en péril la vie non seulement des pilotes et aéronautes, mais encore par voie de conséquence, celle des terriens;

"Estime qu'il y a lieu de réglementer internationalement la circulation aérienne en sauvegardant aussi bien les intérêts des particuliers que les intérêts souverains et fiscaux des Etats.

"Pour parer à ces graves inconvénients et dangers, la Commission s'adresse respectueusement au Gouvernement de S. M. le Roi des Belges, en le priant d'inviter le Gouvernement français, initiateur de la Conférence Internationale de la Navigation Aérienne, réunie à Paris en 1909, à communiquer aux diverses puissances représentées à cette Conférence, le projet que vient d'adopter la Commission Internationale du Droit aéronautique de la Fédération Aéronautique Internationale et à examiner d'urgence s'il n'y a pas lieu de convoquer à nouveau la Conférence Internationale de la Navigation Aérienne, aux fins d'examen et d'adoption du dit projet."

Le Président de la Fédération Aéronautique Internationale,

(Signé) BONAPARTE,
Membre de l'Institut.

APPENDIX C.

Commission du Droit Aéronautique, Bruxelles, Avenue Marnix, 6.

PROJET DE TRAITÉ

Réglementant la Circulation Aérienne Internationale.

TITRE PRELIMINAIRE.

ARTICLE PREMIER.—Les sujets ou citoyens de chacun des Etats contractant jouiront, dans tous les autres Etats signataires, des avantages du présent traité. Ils seront tenus aux obligations qui en dérivent.

ART. 2.—Tout Etat signataire peut, en ce qui le concerne, dénoncer le traité à toute époque.

ART. 3.—Les dispositions du présent traité s'appliquent aux aéronefs. Les aéronefs comprennent: les ballons libres, les ballons dirigeables et les appareils d'aviation.

TITRE I.

Conditions de Circulation.

ART. 4.—Est admis à circuler au-dessus des territoires des Etats signataires à y atterrir et à y prendre l'air tout pilote d'aéronef qui sera porteur:

1° Du certificat d'immatriculation de l'aéronef;

2° Du brevet de pilote de la F. A. I.

Le pilote devra se conformer aux prescriptions du présent traité et aux lois et reglements du pays où il se trouve.

ART 5.—Tout aéronef doit porter de façon visible, de deux côtés, avec les numéros d'immatriculation qui l'identifient, l'indication de la nation où les formalitiés de l'immatriculation ont été remplies.

ART. 6.—Le nom du pays où les formalitiés d'immatriculation ont été remplies est indiqué:

Pour	l'Allemagne,	par la lettre	D
,,	l'Autriche,	,, ,,	A
,,	la Belgique,	,, ,,	B
,,	Danemark,	,, ,,	D A
,,	l'Egypte,	,, ,,	E G
,,	l'Espagne,	,, ,,	E
,,	les Etats-Unis,	,, ,,	U S
,,	la France,	,, ,,	F
,,	la Grande Bretagne,	,, ,,	G B
,,	la Hongrie,	,, ,,	H
,,	l'Italie,	,, ,,	I
,,	la Norvège,	,, ,,	N
,,	les Pays-Bas,	,, ,,	N L
,,	le Portugal,	,, ,,	P
,,	la Républ. Argentine,	,, ,,	R A
,,	la Russie,	,, ,,	R
,,	la Suède,	,, ,,	S
,,	la Suisse,	,, ,,	C H

TITRE II.

Règlement de la Circulation Aerienne.

CHAPITRE I.

RÈGLES CONCERNANT LES FEUX.

ART. 7.—Les règles concernant les feux réglementaires doivent être observées par tous le temps, du coucher au lever du soleil et, pendant cet intervalle, l'usage de phares indépendants de ces feux est autorisé, à condition que les phares ne puissent être pris pour un des feux prescrits.

ART. 8.—*Feux que doivent porter les ballons dirigeables.*—Un ballon faisant route, c'est-à-dire ayant une vitesse propre, doit porter :

(*a*) A l'avant un feu *blanc* brilliant, disposé de manière à montrer une lumière ininterrompue sur tout le parcours d'un arc horizontal de 220°, soit 110° de chaque côté de l'aéronef, à partir de l'avant ;

(*b*) A droite, un feu *vert* établi de manière à projeter une lumière ininterrompue sur tout le parcours d'un arc horizontal de 110°, c'est-à-dire depuis l'avant jusqu'à 20° sur l'arrière du travers, du côté droit ;

(*c*) A gauche, un feu *rouge* établi de manière à projeter une lumière ininterrompue sur tout le parcours d'un arc horizontal de 110°, c'est-à-dire depuis l'avant jusqu'a 20° sur l'arrière du travers, du côté gauche ;

(*d*) Les trois feux, *blanc, vert et rouge,* devront être visibles dans chaque plan vertical correspondant à leurs zones respectives dans toute direction comprise entre la verticale, vers le bas et une ligne se rapprochant autant que possible de la verticale et faisant un angle d'au moins 30° avec l'horizontale, vert le haut,

(*e*) Les faux de côté, *vert et rouge,* devront être munis d'écrans disposés de telle sorte que leur lumière ne puisse être aperçue de côté opposé ;

(*f*) Le feu *blanc* doit être visible à une distance d'au moins 4 kilométres, les feux *vert et rouge* à une distance d'au moins 2 kilomètres, par nuit noire et atmosphère pure ;

(*g*) Un ballon dirigeable devra, en outre, avoir en permanence un feu blanc à l'arrière.

ART. 9.—*Feux des appareils d'aviation.*—Les règals relatives aux feux sont applicables aux appareils d'aviation. Toutefois, par une mesure de tolérance temporaire, ils ne sont astreints qu'à porter un seul fanal, disposé de manière à montrer les feux réglementaires.

ART. 10.—*Feux des ballons libres.*—Les ballons libres doivent, avoir prêt à servir, un fanal à feu *blanc* et le montrer à l'approche d'un autre aéronef.

CHAPITRE II.

SIGNAUX PHONIQUES.

ART. 11.—(*a*) Par les temps de brouillard, de brume, de bruine, de neige ou pendant les forts grains de pluie, les aéronefs à moteur doivent, tant de jour que de nuit, faire usage de signaux phoniques puissants discontinus ;

(*b*) Dans les mêmes conditions, les ballons libres devront faire usage de signaux analogues lorsqu'ils seront dans le voisinage d'aéronefs à moteur.

XUM

CHAPITRE III.

RÈGLES DE ROUTE ET DE MANŒUVRES.

ART. 12.—Un aéronef à moteur doit toujours se tenir à une distance d'au moins 100 mètres de tout autre aéronef, dans toute direction horizontale, verticale ou oblique.

ART. 13.—Les aéronefs à moteur doivent toujours s'écarter des ballons libres.

ART. 14.—Tout aéronef à moteur qui sa rapproche d'un autre en n'importe quel sens doit toujours prendre sa droite, à moins qu'il ne soit et demeure à une distance d'au moins 300 mètres.

ART 15.—Lorsqu'un ballon dirigeable a stoppé volontairement, il doit montrer une boule noire très apparente; il reste, dans ce cas soumis aux mêmes règles que les aéronefs en marche.

S'il n'est plus maître de sa manœuvre pour cause d'avarie, il doit montrer deux boules noires très apparentes, placées verticalement l'une au-dessus de l'autre. Dans ce cas, il est assimilable aux ballons libres.

La nuit, dans les deux cas, il ne montre que le feu blanc et il est assimilable aux ballons libres.

CHAPITRE IV.

SIGNAUX D'ATTERRISSAGE ET DE DÉTRESSE.

ART. 16.—Lorsqu'un ballon dirigeable se dispose à atterrir, il doit :

De jour, faire apparaître sous la nacelle un pavillon rouge de forme triangulaire,

De nuit, faire clignoter ou agiter un feu blanc en maintenant allumés ses feux réglementaires.

ART. 17.—(*a*) En cas de détresse, au-dessus des terres comme au-dessus de la mer, un ballon dirigeable doit :

De jour, faire apparaître sous la nacelle un pavillon rouge triangulaire et montrer les deux boules noires superposées prévues à l'article 9;

De nuit, agiter ou faire clignoter un feu blanc en éteignant ses feux de côté;

De jour comme de *nuit,* il doit en outre faire usage d'un signal phonique.

(*b*) Un ballon libre en détresse doit :

De jour, montrer sous la nacelle un pavillon rouge triangulaire et la *nuit,* agiter un feu blanc;

Il peut, en outre, de *jour* comme de *nuit,* faire usage d'un signal phonique.

CHAPITRE V.

EMPLOI DU LEST.

ART. 18.—Il n'est permis d'employer comme lest qu'une matière ne pouvant offrir aucun danger pour les tiers, tel que du sable très fin ou de l'eau.

TITRE III.

Douane.

CHAPITRE I.

DISPOSITIONS GÉNÉRALES.

ART. 19.—Les aéronefs atterrissant en pays étranger et destinés à être réexportés, bénéficent, ainsi que leur équipment, du régime de l'acquit-à-caution, de l'admission temporaire ou de la consignation des droits, ou du triptyque.

ART 20.—Les approvisionnements et les matières destinés au fonctionnement des appareils de l'aéronef, bénéficient des tolérances réciproques de la part des Etats signataires.

ART. 21.—Les bagages et objets personnels du pilote, hommes à bord ou passagers sont, lors de l'atterrissage en pays étranger, soumis au même traitement que les objets de même nature importés par les voyageurs ou passagers sur les frontières de terre ou de mer.

CHAPITRE II.

TRANSPORTS DE MARCHANDISES.

ART 22.—Le pilote de tout aéronef transportant des marchandises ne peut circuler que s'il possède à son bord, savoir : dans le pays où l'aéronef a été immatriculé, un permis de circuler émanant de l'autorité compétente.

En pays étranger, un laissez-passer et pour passer une frontière quelconque, à l'aller et au retour, un bulletin de douane.

ART. 23.—Le pilote de tout aéronef transportant des marchandises que veut se rendre à l'étranger doit, avant de prendre l'air, faire visiter son aéronef par un agent fiscal. Celui-ci constate le jour du départ, la nature et la quantité des marchandises, bagages ou objets personnels du pilote, hommes à bord et passagers, sur un registre spéciàl dont il délivre un duplicata au pilote.

Ce duplicata porte le nom de Bulletin de douane.

Ce bulletin indique :

1° La nationalité du navire aérien ;

2° Son immatriculation ;

3° La nature et la quantité des marchandises, bagages ou objets personnels transportés ou leur absence ;

4° Le lieu et la date du départ ;

5° Le nom du lieu de destination.

Le bulletin de douane n'est délivré que contre remise du permis de circuler ou s'il s'agit d'un navire étranger du laissez-passer.

ART. 24.—Arrivé à destination, le pilote de l'aéronef doit, dans le plus bref délai, remettre à l'agent fiscal son bulletin de douane et acquitter entre ses mains les droits de douane, s'il en est dû.

ART. 25.—Contre l'acquit des droits, il est remis au pilote un laissez-passer en échange du bulletin de douane.

Le laissez-passer permet de circuler au-dessus du pays où a été délivré cette pièce justificative du paiement des droits.

ART. 26.—Le pilote de l'aéronef étranger qui veut regagner son pays ou passer dans un autre pays étranger, doit obtenir d'un agent fiscal un nouveau bulletin de douane en échange du laissez passer.

ART. 27.—Le pilote de l'aéronef qui regagne son pays doit, dans les vingt-quatre heures de son arrivée, remettre à l'agent fiscal de la localité son bulletin de douane et acquiter les droits ; s'il en est dû. En échange, il lui est remis un permis de circuler.

ART. 28.—Le pilote de l'aéronef qui, se trouvant à l'étranger, gagne un nouveau pays étranger, remplit chaque fois les mêmes formalités.

Il ne peut circuler en pays étranger que porteur d'un laissez-passer délivré après l'acquit des droits de douane, s'il en est dû.

ART. 29.—Le pilote de l'aéronef qui, porteur d'un bulletin de douane, atterrit en cours de route, pourra dans les limites des nécessités de la locomotion aérienne, subir la visite de l'agent fiscal ou de police locale, qui constatera sur le même bulletin la nature et la quantité des marchandises, bagages ou objets personnels, à l'atterrissage et au départ.

ART. 30.—Sur la demande qui lui en est faite, tout agent fiscal doit délivrer un bulletin de douane au pilote qui, venu de l'étranger sans transporter de marchandises, veut repartir en en transportant.

XUM

CHAPITRE III.

SANCTIONS.

ART 31.—En cas de contravention aux présentes dispositions, comme en cas de contrebande dûment constatée, le pilote est poursuivi selon les lois du pays lésé.

APPENDIX D.

FÉDÉRATION AERONAUTIQUE INTERNATIONALE.

Permis de Circuler.*

Valable du .....
jusqu'au .....
délivré à M .....
domicile à .....

pour un { Ballon libre / Dirigeable / Aéroplane / Hydroaéroplane }

ayant pour pilote M .....
domicilié .....
porteur du brevet de pilote n° .....

SPECIFICATION DE L'APPAREIL:

Nom .....
Marques .....
Types .....
Numéros .....
Immatriculation .....
Poids .....
Enveloppes .....
Cubage .....
Fuselage .....
Ailes .....
Flotteurs .....
Nacelle.....
Etc. .....

SPECIFICATION DE MOTEUR.

Type .....
Marque .....
Force .....
Numéros .....
Poids .....
Etc. .....

Bulletin de Douane.*

Délivré :

(*a*) Contre remise du permis de circuler n° ..... (spécification);

(*b*) Contre remise du laisser-passer n° ..... (spécification);

à la date du .....

à M .....

domicilié .....

en vue de son départ de .....

le (date) .....

pour (destination) .....

sur un aéronef de nationalité .....

immatriculé .....

Spécification de :

(*a*) L'appareil :

ses agrès .....

ses instruments .....

ses accessoires .....

(*b*) La nature et le poids de :

provisions .....

bagages .....

chargement .....

objets personnels .....

.....

.....

.....

Spécification des hommes de bord et passagers .....

.....

.....

.....

.....

.....

Laisser Passer.*

Délivré (contre acquit des droits ou constatation de l'absence de matière imposable) :

le (date) .....

à M ....

domicilié .....

valable du .....

jusqu'au .....

pour un { Ballon libre / Ballon dirigeable / Aéroplane / Hydroaéroplane }

ayant pour pilote M .....

domicilié .....

porteur du brevet de pilote n° .....

*The seal of the issuing authority would have to be affixed in the respective contracting States.

SPECIFICATION DE L'APPAREIL :

.....
.....
.....
.....
.....

SPECIFICATION DE MOTEUR.

.....
.....
.....
.....
.....

Le présent laisser-passer devra être remplacé à la cortie par un bulletin de douane.

DISCUSSION.

Mr. GRIFFITH BREWER : Mr. Wallace has asked me to explain the Rules of the Road proposed in the Draft Treaty. I will try to do this as briefly as possible.

In the first place, every aircraft is to be marked with the letters designating the country to which it belongs ; French aircraft should be marked F, British aircraft should be marked G.B. The fact that these letters G.B. are my initials need not deter you from using them.

When travelling at night, an aircraft under power must show a white light visible ahead through an arc of 220°, namely 110° to either side ; a green light visible through an arc of 110° on the starboard side ; and a red light visible through 110° on the port side ; whilst at the stern a white light must be shown. You will observe that the lights employed in marine navigation are adopted as far as they are applicable in air navigation.

A free balloon is to be marked by a single white light, and all aircraft moving through the air must keep clear of a free balloon in the same way that vessels under way keep clear of a vessel at anchor.

When a dirigible balloon becomes disabled and floats in the air like a free balloon, it is then to be treated as a free balloon, and every other aircraft under way must keep clear of it.

In time of fog, audible intermittent signals are to be sounded by all aircraft.

With regard to the rule of the road, when two aircraft approach each other, in no matter what direction, they must turn to the right if necessary in order to avoid approaching closer to each other than 300 metres. Prior to alighting, an aircraft should display a red triangular flag below the car by day, and by night wave a white light, while still retaining the regulation lights.

If the aircraft is in distress, by day it should display a triangular red flag and suspend two black balls superposed, and by night wave a white light while

extinguishing the side lights. A phonetic signal should also be used. It may be difficult for pilots of aircraft in distress to conform to these rules, but no doubt they will do their best.

The regulations terminate with a statement as to the restriction of ballast, which should be such as not to endanger third parties; fine sand and water are recommended for this purpose.

These regulations are not put forward as final, for it would be impossible to foresee what changes may be required to meet the development of the art of aeronautics. For instance, M. Pégoud and Mr. Hucks when flying upside down would find the red light where the green should be, and the green in the position of the red, but no doubt an inverted brain will be able to cope with this problem and effect a quick change when necessary.

This is all I have to add to Mr. Wallace's excellent paper.

Mr. MERVYN O'GORMAN: It is interesting to be reminded that the English representatives of the International Arbitration League proposed that aerial warfare be banned in the *interests of peace*.

Doubtless with such a title the Arbitration League who wish all warfare banned considered that the greater included the less, yet one cannot help thinking that this, like many another apparent platitude, was false, and one cannot but endorse the view of Mr. R. Wallace in his lecture to-night that the interests of Peace are always subserved by the exchange of ideas arising from free locomotion, through whatever medium.

Also, in this, as in other branches of industry in the past, the forcing of the pace of progress by the opposing military authorities in this case presses forward the very freedom of locomotion which makes for peace by the indirect route of mutual acquaintance through easy and quick travel.

This, like many other side-lights cast on the broader aspect of Aeronautics, makes more than full amends for the fact that the lecture itself is what its author described as discursive.

It has doubtless occurred to many that, if all fighting between nations could again be limited by common consent to the use of the short sword of the Romans, "the weapon of courage," enormous economies could be made, while the factor of value to the race, that the strong, the brave, the worthy and the brainy should survive and rule, would still be secured. The economy in armaments might amount to some 500 million pounds sterling per annum. It would be interesting to speculate as to whether aerial fighting may not in a surprising manner re-introduce a new "weapon of courage," if not as cheap as the short sword, at any rate far cheaper than the present-day guns and warships.

Suppose—for it is only supposing—that the destructive effects of torpedoes and bombs from aircraft can chase the £2,000,000 battleship off the seas. The fighting value of such ships will disappear and expenditure thereon vanish as useless. It will in part be re-directed to the enlargement of submarines, but this will not require anything like such great sums for a long time to come. The money expended on aircraft will gradually but most surely make them commercial appliances, and their extraordinary freedom of motion will then make for the greater international friendliness alluded to. Shipping trade routes could then be protected by means of aircraft against attacks from aircraft, and this is cheaper than protecting them by warships against attacks from warships, and so a portion of the economies desired be obtained.

The idea put forward by Mr. Wallace that an aerial international police

may prove efficient to enforce the awards of a Court of Arbitration does not appear to be a promising one—if it is to be based, as he says, on banning the use of aircraft to the separate States; this, it will be seen, is retrograde, even from the cause of economical self-protection, as also from the cause of rapid interchange of ideas and freedom of commerce, which are the greatest gauges of Peace.

Nor is the giving the free use of the air to all and sundry over every place in every country proved to be a goal which those who are interested in the progress of aerial work should support. It may be so, but certainly the case is not made out. Far from agreeing that England set a bad example to the nations by being the first to prohibit flight over certain areas, it appears that a different point of view is justified, namely, that England, generally slow to move, showed signs of unwonted astuteness in early appreciating a position which all are taking up—because they had to.

A very interesting point, likely to be a very delicate one in future years, underlies the query as to whether the "three mile from the shore limit" is adequate now that warships can carry aircraft. It does not seem to be improbable that the large submarines of the future will also carry aircraft, even if the battleship of to-day vanishes. How, then, that shore limit is to be extended is indeed a problem.

It appears that, where a summary of the theories in vogue is put forward, one consideration is at once sufficient to spoil the sweet generality of theory number one: "That the air space is free to the use of all without restriction of any kind, and that over it no dominion, sovereign or otherwise, can be imposed." Let us look at the foundations of Roman practice. When Remus jumped over the wall of Romulus, his passage taking place through the air, it is not reported that Romulus objected because his wall was kicked or damaged. He considered that the passage infringed his rights. When aircraft fly over a cover and disturb the birds, or fly over crowded places and disturb the Aero Club, we find out automatically that the words "the air space is free to the use of all *without restriction of any kind*" is intolerable to all. That is to say, there must be some height limit. Even Romulus would have felt more tolerant had Remus passed over his wall at a height of 5,000 feet, and it seems likely that the height limit is the crux of the situation, both as regards the three mile margin round the shore and passing over powder magazines, etc.

Just for the present moment the aeroplane or balloon that cannot suffer from an "unavoidable alighting" is left out of count, and regulations are hampered by the fact that the craft regulated for cannot be expected to comply with a ruling which excludes reference to unavoidable descents. Quite soon this technical point will disappear. Aircraft with multiple engines, no more likely to fail simultaneously than is the supply station for electric current, will soon be the only tolerable craft, an air endurance of twelve or twenty hours the only conditions in which such craft will be permitted to ascend save for exceptional purposes. There will be something analogous to the Board of Trade deciding the loading line per ship, the number of "safeties" for lifts, etc.; and amongst the "safeties" for the air the security against compulsory descents by lack of fuel, or lack of engine reduplication, will be considered.

The registration of aircraft, though postponed by various Governments, is seen, by the clubs and bodies really in touch, to be inevitable, and, in fact, desirable. Naval and military aircraft will certainly not figure in the published register—their own departments can be fully trusted to record their units, despite the entirely foolish attempts to make political fun out of the count of British military aircraft—but the most interesting and puzzling result of the advance of air science lies in the matter of Customs duties.

Inspection of the controls of aircraft in the country of departure—say England—in the interests of the country of call is unthinkable. Inspection on alighting involves all countries in having Custom House officers over their whole surface, in numbers in excess of the number of inhabitants. That alighting at Calais, or near other large ports, should be obligatory on all entering aircraft is quite impracticable, not only, as was suggested, because the arrival aerodrome at Calais, say, would become a pandemonium of delayed and angry aeronauts scattered over a wide area, which could not be supervised and inspected in any reasonable time, but far more because the necessary circling for the purposes of alighting in the correct direction up wind, the possibility of passing the border during the night hours, or over clouds or in a fog, make it so easy to drop packages in the country of entry that such inspection would become a farce.

The suggestion may be made that there should be a Customs Police equipped with aircraft to pursue and watch traders, but with the twenty-hour aeroplane and the numbers easily foreseen to be involved, and with the carrying business taking place over countries in which no alighting whatever is contemplated, there would have to be one flying Customs officer for every aircraft launched. He could be easily given the slip in the night, in clouds or fog, or by day in any more speedy machine; so here, too, we find failure inevitable. The nations must face the peculiar problem that, so far as air-borne goods are concerned, free trade is unavoidable, and we shall find that a ton of tobacco, lace, silks, and even delicate materials, such as watches and instruments, if they be susceptible of perfect packing, will be imported everywhere without the possibility of interference.

That the air police should shoot down at sight those who fail to alight at their declared destination or when called on is to invest them with the combined qualities of judge, jury, and hangman, with the additional presupposition of infallibility in appreciating whether an error of navigation is not in question—so it may be dismissed.

The general value of Mr. Wallace's paper cannot be denied, and I join with all others who have so heartily indicated their approval and thanks by applause.

Mr. PAWLEY BATE, in response to a call from the Chairman, briefly criticised the assumption underlying the phrase "the right to fly." He did not think any State would concede that right in any form, at any rate until it had become clear what forcible means of controlling flight the future development of aeronautics was going to put in the hands of Governments. At the present time attempts to define it could at best be described by the phrase which Sir John Seeley once used of the paper constitutions that were devised for revolutionary France, "innocently academic."

Mr. A. E. BERRIMAN said that the most interesting point that followed from the suggestion that Customs and other formalities must be gone through on landing was that it would lead to the Government subsidising aerodromes in order that they might control the traffic, all landing outside aerodromes being forbidden. He foresaw very great difficulties in controlling air traffic, however.

Mr. JUSTICE ATKIN said that he found it was his duty to sum up the discussion. He felt less difficulty in summing up on a question of law, because, in his opinion, on one important branch of the question, viz., the International side, there was no law. Whatever International law meant it at any rate involved the existence of definite and ascertained rules of conduct, based either upon custom or accepted practice or upon principles assented to by most of the civilised nations. In reference to the right to fly over the territory of a foreign country, there was no custom or accepted practice or principle which had received

general assent. Whether the theory propounded was the complete freedom of the air, or freedom subject to the right of the subjacent State to impose restrictions for customs and military purposes, or sovereignty of the subjacent State subject to the right of free friendly passage, it appeared to him impossible to say that such theory had become part of international law. He went further, and expressed his belief that, if all the international jurisconsults in the world were gathered together and unanimously accepted any of the suggested theories as law, it would have small effect upon the counsels of any nation which for any cause wished to close its air space to foreign air vessels. Nor was it conceivable that any such action on the part of any nation would be regarded by any other nation as a breach of any international obligation. This country had already by legislation taken the right when it pleased to close the whole or any part of its air space to any air-vessel; and, in fact, had closed the air space over certain territory. He understood from the lecture that France had taken the same power for military purposes; and it was inevitable that other countries would follow suit. It seemed to him prudent for aeronauts to recognise that there was at present no law or general rule adhesion to which could be demanded of foreign nations, and to devote their attention to securing that the regulations adopted by nations for governing as far as possible flight over their territories should be uniform and free from vexatious interference with friendly flight.

When one turned to the domestic law of this country he said that he considered the maxim *cujus est solum ejus est usque ad cœlum* was well established, and that the right of the owners of the soil extended in law up to the highest foot of incumbent air space. A very short flight, therefore, seemed to involve the aeronaut in a series of trespasses. He did not think, however, that this result need cause the Aeronautical Society any serious alarm. If the aeronaut caused any damage or annoyance, as, for instance, by letting substances fall from the air-vessel, or possibly by seriously alarming flocks or herds, he would be rightly held liable. In the absence of any damage or annoyance he would for all practical purposes be free from liability either by way of damages or injunction.

He wished to thank the Society for giving him the opportunity of listening to Mr. Wallace's important and interesting lecture and the useful discussion that succeeded it.

Mr. WALLACE having briefly replied, on the proposition of Mr. Mervyn O'Gorman a vote of thanks to Sir Richard Atkin for his kindness in presiding was unanimously accorded, with acclamation, and the meeting terminated.

The SECOND MEETING of the FORTY-NINTH SESSION of the Aëronautical Society of Great Britain was held at the Royal United Service Institution, Whitehall, S.W., on Wednesday, 3rd December, 1913, at 8.30 p.m. Major-General R. M. Ruck, C.B., R.E. (retired), presided.

THE COMING AIRSHIP.

BY CAPT. C. M. WATERLOW, A.F.AE.S.

The subject of my paper is the airship of to-morrow, and if I look at it rather from the point of view of military requirements, you must bear in mind that it is these requirements which have made it what it is. Commercial needs and even Naval needs have played a very small part hitherto in its development, though they may be expected to exert considerable influence on its progress in future.

Prejudice Against Airships.

Looking back over the past few years, we find an extraordinary prejudice against airships in this country, fostered in the most amazing manner by the Press, both lay and technical. This did not begin to dissipate until the autumn of 1912, just over a year ago.

As late as October, 1912, the "Times" wrote a leading article on the folly of spending money on airships, taking as its text the accident to "Gamma" after the manœuvres of that year. You may remember that the steering gear jammed while over Salisbury Plain and it became necessary to rip the envelope. The design of the cords actuating the ripping panel was faulty and in consequence the panel did not open properly and the envelope took a great time to empty. While emptying it bumped the car along the ground and naturally did great damage. The lesson to be learnt was, I need scarcely say, that our arrangements for ripping were faulty; and when the ship was repaired they were greatly improved.

And then again within the past few weeks we have the "Standard" leader writer telling us that after the two recent catastrophes in Germany the rigid type of airship ought to be abandoned. He says:—"The inflated balloon with a rigid framework and elastic envelope is clearly not strong enough to stand the strain to which it is exposed in a high wind." And again:—"A row of silk or canvas gasbags, with tons of heavy machinery attached to them, are too fragile to bear the stress of air pressure when driven by an 800 horse-power engine at 50 or 60 miles per hour." There is nothing to support either of these theories in the accounts of the accidents; absolutely nothing, and yet the public are thus gulled into a disbelief in airships at a time when they need the utmost possible support in this country. Could not the Council of this Society take steps to controvert these more flagrant cases that from time to time arise? It is most important that public opinion should not be misled.

Going back once again to the autumn of 1912, we suddenly find a most remarkable change of opinion; the very writers who a month or two previously had been declaring the airship to be useless now painted lurid pictures of England's ruin unless a big airship programme was immediately forthcoming.

It is scarcely to be wondered at their thunderings had little effect, people were naturally sceptical. The cause of all this excitement was the alleged

"scare ship" over Sheerness and elsewhere; and it would seem that it is to this —possibly phantom airship—that we owe the present activity in airship construction, such as it is.

Even now you will find writers on aeroplanes declaring roundly that any airship is at the mercy of any aeroplane which chooses to assail it; but to make their point they invariably describe the aeroplane of the day after to-morrow as operating against the airship of yesterday; in other words, they give full play to their imagination or knowledge in describing the aeroplane of the future while denying any possibility of development to the airship, of which they know but little.

I don't think it is generally realised that the airship has by no means reached such an advanced stage of development as the aeroplane; the possibilities and probabilities of the future are very rosy and very wonderful.

The case of the airship *v.* aeroplane is rather outside the scope of this paper, but I would urge that when discussing it we should have fair play as between the two types.

Development Here and Abroad.

The development of the airship in England and on the Continent has proceeded on different lines, due, I fancy, largely to the differences in the nature of the countries and of national temperament. *Here*, we have set rather the maximum power of control and handiness as our aim; abroad, they have gone in for weight-carrying capacity and long distance work. In consequence the foreign airships appear clumsy to our eyes and difficult to manage; while ours, no doubt, appear to them as puny and contemptible.

When the Parseval airship, which now belongs to the Navy, descended after its first flight in this country, I asked the German pilot what he thought of our country from the air. He remarked at once that it was so very full of trees and added that he did not consider it a good country for airships.

He was right and yet wrong; right from his own point of view and wrong from ours.

It is undeniably *not* a good country for German airships such as the Parseval and others, but it is excellent for the type that has been developed in England.

Now please do not misunderstand me in this connection—I do not now refer to the relative sizes of the airships, but to their methods of control.

In Germany or France an airship pilot selects a wide open space to land in; in England we look for a field completely surrounded by trees and just big enough to take the airship.

I will show you some slides illustrating this point at the end of this paper. On manœuvres last September we had two airships, "Delta" and "Eta," and these were moored out in the open behind a row of trees about 55 feet high, such in fact as one finds all over England. "Delta" stands 65 feet high, that is to say, quite markedly more than a Zeppelin or other rigid ship, and yet throughout the week it was in the open, whether the wind was 50 m.p.h. or whether it was a calm; the ship's crew of six or eight were ample to look after it, except when landing. This compares favourably with the 200 or more required to hold a Zeppelin in the open.

And I maintain that a rigid ship of the largest size could have been managed

in the same way by a score or so of men, though possibly, and perhaps I should say probably, not of the Zeppelin type of construction.

Both our two ships were out in much rain and other bad weather.

Speed.

I want next to refer to speed. A year or two ago a well-known writer informed the world, through the "Daily Telegraph," that non-rigid ships could not hope to greatly exceed 40 miles per hour, because the flexible envelope would not stand it.

To-day the "Astra Torres" airship, or as it now is, Naval Airship No. 3, has achieved a speed, independently of the wind, of over 51 miles per hour.

It is therefore the fastest non-rigid airship in the world and may well be even better than the Zeppelins, but precise information on this point is lacking.

Competent designers assure us that 55 miles per hour can be easily obtained and another year or so may produce the 60 miles per hour airship.

From the war point of view this increase in speed has a most important corollary; it means that the era of the slow speed aeroplane, that is to say, those of under 60 miles per hour, will be gone for ever. Everything that they can do on service can be done so much better by the airship.

If ever airships achieve 70 miles per hour it is difficult to see where the aeroplane, as we know it to-day, will come in at all for war purposes; and this, of course, applies equally to seaplanes.

This is no idle boast, but the natural result of increase of speed.

Safety.

Before dealing with improvements in technical details I want to touch on one big question, and that is safety.

We have all been appalled by the recent disasters in Germany. We can only surmise what happened in each case and must on no account, therefore, jump to conclusions too hastily.

As I said before, the statement in the "Standard" that the Zeppelin is proved a failure and should be abandoned, seems to me particularly foolish and unfortunate.

We are very badly served by our Press in Aeronautical matters; so-called experts do not hesitate to write down amazing rubbish, and editors print it gladly; the general public accept it as gospel, and so the trend of public opinion is induced into wrong lines and the cause of Aeronautics suffers. But to return to the question of safety. In any airship *fire* is above all the greatest danger.

If you will bear with me I would like to analyse this question a bit.

There are three main sources of fire:—

(1) From the engines.

(2) From the "wireless" apparatus.

(3) From other sources, such as defective wiring in the electric lighting circuit, matches, and so on.

There are also three sets of combustible material which may be set alight :—

(1) The gas within the envelope

(2) The petrol for the motors.

(3) Such portions of the car and framework as are not made of metal.

Of the sources of fire :—

(1) At the engine a great deal can be done to render the risk small, but it cannot be entirely eliminated. The carburettor can be and should be enclosed in wire gauze, and the red hot portions of the exhaust pipes should be dealt with in the same way. Large and ample silencers are valuable because not only do they quiet the engines, but they cool down the exhaust gases below the temperature of ignition.

(2) All dangers from " wireless " sparks can be eliminated by suitable design, but the apparatus wants most careful watching as accidental damage to the insulation is almost certain to cause a spark.

(3) Risks from other sources are small and can be easily provided for.

Then as to combustible materials. We have to use hydrogen in the envelope, and there must be occasions when that hydrogen must escape. An entirely satisfactory automatic valve which can be placed on top of the envelope has yet to be devised.

In semi and non-rigid airships the automatic gas valves are placed at the extreme stern on the under side of the envelope. In rigid ships they cannot be placed there, because of the number of separate gas compartments, and there is some ground for believing that the importance of this point has been overlooked.

It is possible, though I must confess I think it is unlikely, that a sufficiently light gas can be found which, when mixed with hydrogen, will render it non-inflammable, and yet not materially impair its lift. It is certainly a point to which chemists should turn their attention.

Petrol we have to carry ; we may use heavy oils one day—certainly not for some time.

It is scarcely necessary to say that petrol is harmless while enclosed in its tanks, especially if they are far removed from any source of fire. We have therefore two opposing requirements :—For maintaining balance it is necessary to keep the tanks amidships, and as a fire precaution to keep them away from the engines.

One solution would be to keep them inside the envelope, but this adds a variety of other difficulties in connection with refilling, leakage, and so on.

If petrol is carried near the engines, it should be aft them so that petrol vapour, due to leakage, is carried away, by the natural draught, out of danger.

It is undoubtedly better if all fabric and other combustible material be kept away from the car ; but this involves an increase of weight which cannot be faced in small ships and we have then to resort to fire-proofing and similar palliatives.

Of risks other than that from fire, I look upon the possibility of a propeller blade breaking and flying into the envelope as the worst.

This danger is comparatively small in a Zeppelin, because the gas is confined in 17 different compartments and only one can be rent by a propeller breaking.

In a non-rigid ship such an accident will be fatal and involve the complete

destruction of the ship unless the envelope is provided with a proper system of internal partitions. Partitions are also needed for other reasons as I will show below.

This is no small risk, as such things as a cap, a nut, or other article getting into the revolving propeller is practically certain to cause the blades to break and fly.

Guards are not practicable for the large propellers now in use, and in any case their weight and head resistance render them out of the question.

There are, of course, other risks in airship work, but they are of lesser importance and need not be considered in estimating the safety of airships.

Design Details.

To turn now to matters of detail in design.

ENVELOPES.—Take the envelope first. This is usually made of a fabric of cotton and rubber and is dyed yellow. In England we have also tried varnished silk and gold-beater's skin.

Silk was not a success; difficulty was experienced in making the seams strong enough.

Gold-beater's skin is excellent in many ways; it lasts in the most wonderful manner without deterioration, holds gas well, and can be easily repaired. But in wet weather it absorbs a great deal of moisture and takes an appreciable time to dry. The materials of which it is made are difficult to obtain quickly, and the process of manufacture is rather slow.

Cotton and rubber fabric has been hitherto the stand-by of all airship manufacturers. It is, however, heavy compared with silk, and succumbs very quickly to the effects of rain and sun. It absorbs a fair amount of moisture in wet weather, but not so much as gold-beater's skin. It is easy to repair and can be manufactured with ease by machinery.

A new material has now been discovered, and it is hoped that with this we shall have the following advantages:—Firstly, it is easily made; secondly, it will hold gas well; thirdly, it will not deteriorate; fourthly, it will absorb no moisture. So far these advantages have been borne out in practice, but further trials will be necessary before we can say quite positively.

It has one additional advantage and that is it will not yield the secret of its manufacture by examination or analysis.

The advent of such a material as this will have a great bearing on gas consumption during a campaign and will entail very much less gas transport than would be otherwise the case.

PARTITION OF GAS VESSEL.—The second improvement which I foresee is an arrangement of partitions in the envelope. This applies more especially to semi and non-rigid airships, in which, at present, all the gas is in one container. Partitions are very necessary as a safety device and for war airships.

Without them a single bullet hole means a continual leakage until it can be repaired; with a system of partitions the leakage is reduced to a manageable quantity; in cases where long flights are made the importance of this becomes very evident.

It is here that the rigid type scores heavily; Zeppelins, for example, have 17 separate gas containers.

XUM

GUN MOUNTING.—To turn to other points, I see no insuperable difficulty in mounting guns on the top of a semi or non-rigid airship; weapons are essential in such a position for protection against aeroplanes, and an airship which lacks them cannot expect to survive long in time of war.

POWER PLANT, Etc.—In the car and machinery, present tendencies point rather to separate engines of not more than 200 horse-power, each driving a single propeller, the engine, propeller arm shafting and propeller all forming a single unit which can be removed bodily if desired or in case of damage.

For the sake of smooth running 6-cylinder engines and 4-bladed propellers seem likely. An airship would be equipped with two, four, or six power units, according to its size.

CONTROLS.—On no subject do opinions differ more than on the arrangement of controls. Almost all pilots I have met have their own favourite arrangement.

Personally, I hold that the pilot should have all controls within his reach and view; though whether he manipulates them directly or moves a telegraph instrument to warn his subordinates, depends on the size of the ship.

Landing.

Landing an airship gently requires the utmost nicety of judgment and a very thorough and long apprenticeship; there are so many factors to take into account.

With swivelling propellers it is possible to land with ease and safety when both very much lighter and very much heavier than air.

In "Delta," though quite a small ship, ascents and descents have been made with the ship as much as 650 lbs. heavier than air, and on two occasions I landed when 200 lbs. lighter than air. One of these was after an eight hours' flight, the other after a parachute descent from the airship.

This gain in buoyancy on a long flight is a difficulty which in larger ships would have to be overcome by special means. In the Naval rigid airship, built at Barrow a year or two back, an attempt was made to conserve the water vapour given off in the products of combustion of the petrol and air. There are many practical difficulties which render this impossible on a small airship, but it is a point which will certainly require attention.

Suggested Army Airship.

For our Army expeditionary force I think the coming airship—or perhaps I should say the "not-coming" airship, as they have been abandoned by the Army—will be one of about 300,000 to 350,000 cubic feet capacity; that is a little bigger than Naval Airship No. 3, the "Astra-Torres." It would be of the non-rigid type with a car like our "Eta," speed 55 miles per hour, crew of eight or nine. To carry nine hours' fuel supply at full speed. Designed to ascend to 5,000 feet with four hours' fuel supply; ballonet capacity up to 8,000 feet; mount two automatic guns, one on the top of the envelope and one in the car, both designed to shoot all round the compass.

Two such airships could be run by an airship squadron of the same size as that which is laid down in the existing war establishments and with the same amount of transport. The ship could be readily packed for transport and could be used equally well on the continent or for "savage" warfare.

The coming Naval airship I prefer to say nothing about, perhaps there are Naval officers present who will be able to enlighten us.

Commercial Airships.

For commercial purposes I believe the airship to have a great future.

Even by now we ought to have had a Paris to London service, or at least a Cross-Channel one.

Airships will doubtless come into use in connection with the Post Office, and, as time goes on, for newspaper delivery.

I can imagine reading in an enterprising daily paper that they have established a special airship service to deliver their paper in every village in Norfolk every morning between six and eight a.m.

You can reckon that the ship will leave London at two or three a.m., and flying low over the various villages, will drop a small parachute with a bundle of mails or newspapers.

Why, we could do that with our little "Eta," small though she is, most days of the year.

SPORTING AIRSHIPS.—A few years hence a ship the size of "Beta" will be the aerial yacht of many men who now keep a big motor car; such a ship could be produced at a very moderate figure with the prospect of a sale of 100.

Hydrogen will be as cheap as coal gas, and one "fill" will last a year.

The mechanism will be as simple as a modern motor car and will be within the capacity of a man of the ordinary motor mechanic class.

AN IMAGINARY TRIP.—In conclusion, I would like to take you with me in imagination on a trip on the coming airship from London to Paris.

We entrain at Charing Cross in a slip carriage with the 40 other passengers about five p.m.

Arrived at Woolwich the carriage is slipped and is taken on by an electric locomotive to the airship sheds on the south of Shooter's Hill.

The conductor enters to ask the gentlemen to stop smoking, and at 5.20 we pull up at the little covered station outside the airship shed.

We pass through a turnstile and show our tickets and note that our weight is being taken and recorded as we go by. Those over 13 stone pay excess and in consequence gentlemen who are near the limit have discarded coats and wraps and given them to their lighter friends.

Arrived inside the shed we enter the passenger car.

The "Albatross," as the airship is called, takes a complement of 50 all told and does her 60 miles per hour with ease and comfort.

The men are already in their places in the fore and aft cars and the engines gently humming. The necessary ballast allowances have been made so soon as our weights had been recorded and the airship is only held down by the weight of the two little trolleys under the fore and aft cars.

There are also guylines attached to other trolleys each side, running on their own rails. A man is seated on each trolley, that is six in all. The swivelling

propellers, of which there are two pairs, two fore and two aft, are all in the horizontal lifting position.

The shed doors open by hydraulic power and as soon as they are fully extended we commence to move out, a motor in the leading trolley driving us at 10 miles per hour.

Ahead in the darkness are two lights on the ground, a green and further on a red one. When the leading car approaches the red one it means the ship is clear of the shed, similarly when the aft one reaches the green one. When the ship is clear the three rear trolleys loose their connection and the stern swings round to port in a fresh starboard wind, at the same time the aft propellers revolve and prevent the stern from hitting the ground; a moment later the fore propellers revolve, the fore car is released and the ship springs into the air. We are off. At 500 feet the propellers drive us forward and we seek higher altitudes on the planes.

Looking back over the ground we notice the Shooter's Hill lighthouse winking at us; the white upper light being the county one and the lower red one for the sub-district. All England is lit up in this manner and it takes very little time to ascertain from a light your position in the dark.

Passing over Dartford station at 1,500 feet we notice an illuminated notice on the station roof concerning Mellin's Food. As we pass on towards the coast our wireless operator is receiving a message from Folkestone, telling us to be ready to take in 300 lbs. of local mails.

Ahead of us is the big Mid-Kent light, near Maidstone, giving its two one second flashes followed by 10 seconds darkness. Nearing Folkestone we approach the earth again, and as we get lower the Post Office officials are seen waiting with a big bundle; we drop a rope from the front car which is hooked on and our power winch quickly hauls the bundle aboard. At the same time a small parachute with London letters is dropped over. The sea voyage is dull and uneventful. The passengers are glad to sit down to dinner during the crossing. As we approach Paris we are struck by the big lights on the Eiffel Tower, visible many miles away; later we spot the sheds near Billancourt and light up our landing signal. In reply they hoist three red lights as a signal they are ready to land us.

The swivelling propellers are all turned downwards now, and we approach the ground at the rate of 500 feet a minute. Three hundred feet above the landing ground the clutches are taken out and the propellers turned into the lifting position; our momentum continues to carry us downwards, and 150 feet from the ground the propellers commence to check it, and as we reach the ground our momentum is absorbed and we land as lightly as a feather, half an hour past midnight. But for the 15 mile head wind we should have made a much quicker passage.

Getting into the shed is an easy process, for here they have a circular shed and it can be entered from any direction.

The width of the shed shelters us from all wind and a score of men quickly have the cars fastened down to a pair of trolleys, which are then wound into the shed by a cable.

So concludes our voyage in the coming airship.

At the conclusion of his paper Captain Waterlow showed slides illustrating points to which he had alluded and other details relating to the construction and piloting of airships.

DISCUSSION.

Lieut. N. F. USBORNE, R.N., in opening the discussion, said he agreed with all the lecturer had said in favour of airships, in fact he thought he had, if anything, understated the case. For example, as regards speed, the 60 m.p.h. airship that the lecturer had mentioned as of the future was now almost an accomplished fact. In France dirigibles were being built to do 55 miles an hour, and two that were to be tried in March next ought to reach 60 m.p.h. In Russia an airship to travel 63 miles an hour was under construction. This vessel was intended to carry enough fuel for 36 hours travelling at full speed, so that if speed were reduced to one half it could remain two to three days in the air. It was hoped to reach a height of about 12,000 feet with this vessel. Seventy miles an hour ought to be attained to in a few years, and if that were done and the same rate of progress kept up, airships would be able to face any gale and be largely independent of the weather conditions that were so important to present-day aircraft.

Major B. F. S. BADEN POWELL: I believe that I am accused of publishing the statement that non-rigid airships were never likely to attain any great speed, but I have been unable to find the reference. I was probably referring to the type in existence at that time. However, one statement of mine that I did come across was to the effect that aeroplanes could travel at double the speed of dirigibles. The latter was then probably capable of attaining about 35 miles per hour, and the former 70. That statement is about true to-day. If we have airships able to go 50 miles an hour, we also have aeroplanes that can accomplish over 100. So it may go on, and when we get airships achieving 70 miles we may have aeroplanes going at 140. And speed is a most valuable quality in aircraft. For war purposes it is, of course, all important, and for commerce it is also of the greatest value, since the faster the machine can travel the less dependent is it on adverse winds, and weather is bound to affect greatly air navigation in practice.

It was interesting to hear the lecturer's remarks on the shelter afforded by trees. When in Germany recently I was asking the pilots of the Zeppelins why it was that they always selected the sites for their sheds in wide open plains and not under the lee of trees. They replied that the winds in the open were more steady, while among trees there were liable to be eddies and unforeseen currents. I should have thought it better, nevertheless, to take advantage of all possible shelter when landing—but then I am not an airship pilot of experience.

The possibility of using an uninflammable gas seems to me to be of the greatest importance. Experiments are now being conducted at the National Physical Laboratory on this subject. It has been said, but I do not know with what truth, that a mixture of 9 to 16 per cent. of acetylene with hydrogen is at least non-explosive—and this would not be a heavy gas.

The delightfully described picture of the airship journey of the future is, after all, practically what is now being transacted every day in Germany.

Mr. E. T. WILLOWS was somewhat dubious as to the possibility of utilising trees for shelter so often as the lecturer seemed to hope. He had had experience of trying to shelter behind trees in France, but it was in the winter, and there was all the difference in the world between a thin line of leafless trees and the thick belts of trees in full leaf that the Flying Corps had found so useful in the last manœuvres.

As regards landing, he thought that with swivelling propellers, which he had used on his first airship and which the Government had since adopted, one could make good landings under very adverse conditions.

XUM

While the aeroplane was at present speedier than the airship, it should be borne in mind that the aeroplanes that had attained speeds of 120 miles per hour were racing freaks, useless for war purposes and incapable of mounting a gun, which could be easily carried on airships.

If a comparison were made on the basis of weight carrying, the difference would not be so marked, say between 60 miles per hour for the aeroplane and 50 to 55 for the airship, and he thought the limit of speed would be sooner reached by aeroplanes than airships. The development of airships had been retarded—his own work, for instance, had been very much handicapped. He would like to add that the present height record for a dirigible was 10,000 feet, recently attained.

Mr. MERVYN O'GORMAN said he was glad to have a chance of praising airships. He supported Lieut. Usborne in his optimism. Personally he looked forward to future airships about six times as big as the present Zeppelins. Everything was in favour of making airships big. If you made them small you had to leave out so many of the things that would make them really efficient. The lecturer had mentioned, for example, the need for incorporating some apparatus to conserve the water in the exhaust as ballast, and there were many other similar improvements that could not be put into small ships.

He wished to emphasise the safety of airships. Take the development of the Zeppelin. For twelve years these huge vessels had been carrying their crews of many men many thousands of miles and until the other day no single person had been killed while navigating a Zeppelin. He regarded the safety of the airship as amply proved. The only drawback that could be urged to their use in war was their size as a target, but here one must remember that size was only relative. For example, at long range it was quite immaterial, if you wanted to hit a man, whether you aimed at the exact centre of his eyeball or not, and the fact remained that under war conditions the airship would always be an extremely difficult target to hit in a vulnerable spot.

The great advance in the strength of materials, such as high tensile steels, was very hopeful for the future of airships, and he saw no reason why high speeds should not very quickly be attained. Speed was, in his opinion, the crux of the matter. The non-restricted air-road would render very high speeds quite safe, much safer than on land.

As regards weight-carrying, the airship was, of course, much superior to the aeroplane, in fact, while he had very great hopes of the development of the aeroplane, he thought that whatever the aeroplane could do the airship could do, and do better. For example, what aeroplane could remain in the air for two or three days or carry 30 people?

The fire difficulty was there, of course, but must not be exaggerated. One could find out all the causes of fire and then proceed to eliminate it by tackling them in detail.

Already a patent had been taken out for encasing the gas bag in an outer cover containing a non-inflammable gas. If this were carried out successfully a great reason for apprehension would be removed.

But he wished to emphasise once more that to be able to carry all necessary comfort and safety ensuring devices one must have very big airships.

Mr. C. C. TURNER: Before referring to Captain Waterlow's attack on the Press I should like to point out that in his forecast of the coming airship service between London and Paris he presupposes airships with a speed of only 60 miles per hour. Now you would never have a regular service with such airships. Captain Waterlow pictured a journey against a head wind of only 15 miles per

hour, but you would far more often have winds of 30 or 35 miles per hour at the height at which you would travel. If your mastery of the air is represented by an independent speed of no more than 60 miles per hour you could not have a regular service in these regions. But Captain Waterlow, as other speakers have pointed out, was setting the speed of his airships too low.

I did not expect to be called upon to defend the Press. What Captain Waterlow said was, no doubt, justified, and I am only sorry he did not lay it on stronger. But I am sorry he did not make exceptions. There are exceptions. Captain Waterlow's remarks compel me to be self-assertive. I have for the past six years—and that takes us back to a period long before the British Army did any serious work with airships—been writing in the pro-airship direction, as well as pro-aeroplane. And I am not the only one. One or two other writers on the lay Press have been perfectly consistent throughout.

I was surprised to hear Captain Waterlow advocate the delivery of newspapers by airship. From his previous remarks one would have thought he would be in favour of putting newspapers down rather than taking them up. (Laughter.)

Captain H. F. Wood said he thought it was necessary to defend the aeroplane against some of the remarks that had been made about it. He thought Mr. Willows had put the speed of the weight-carrying aeroplane too low—75 miles per hour was more like latter day performances than 60 miles per hour. As regards height attained, too, he thought the airship would find the aeroplane a formidable opponent.

He was glad to hear Mr. O'Gorman praising high tensile steels and their beneficial effect on the development of airships, but why not also of aeroplanes? He believed in steel aeroplanes, and Vickers, of course, made high tensile steel tube, but when they made Government aeroplanes they had to work to a specification that laid down that all the spars and so on were to be of wood.

Mr. O'Gorman here interposed that a reason for using wood was that high tensile steel tube was very difficult to obtain in quantity in England, but Captain Wood said that he knew where it could be obtained if it were wanted.

Captain Lefroy, R.E., was asked to give the result of his experience with wireless during the recent manœuvres, and stated that they found that about 1lb. weight for every mile range could be attained. Messages had been received quite clearly on the "Delta," without interference. They used a magnifying receiver and the greatest distance was 56 miles. Seventy miles had been done. Their wave length was 200 to 500 metres, as compared with the 600 to 800 metre wave of the field telegraph. The latter said that they could not hear the airship messages unless they tried. For generating the current they found a Douglas motor cycle engine worked admirably. The main engines could of course be used. The sending apparatus weighed 70 to 80lbs. and occupied about 20ins. by 10ins. by 6ins. The receiving apparatus, including magnifiers, weighed about 20lbs. With this 100lbs. apparatus they could communicate with the ground over a 70 mile radius and between aircraft over a 100 mile radius.

Mr. F. M. Green: I have little to discuss on Captain Waterlow's paper as I have had the pleasure of being very closely associated with him on airship work for a number of years and am, in general, quite in agreement with his views.

Airships are at a much lower stage of development than aeroplanes, because there is so very much more work both in the design and the making of an airship that experiments become tedious and costly compared with aeroplanes. Also, the number of people working on airships is very much less than on aeroplanes.

The Chairman: Ladies and Gentlemen,—In the first place I owe an apology for occupying the chair this evening. In the case of lectures of this character

it is usual for the Council of the Society to invite some distinguished official to preside and the response has generally been of the most willing and gratifying nature, but on this occasion there appeared to be a somewhat remarkable reluctance to accept the Society's invitation. Perhaps this is not to be wondered at, partly on account of the fluctuating opinions, alluded to by the lecturer regarding the future of airships, and partly to the necessity for official reticence with respect to design and construction at the present moment.

However this may be, it seems to me that it is all the more desirable from the point of view of the public and of the Society that we should have had this excellent lecture and discussion this evening.

The points of special interest in the lecture were to me :—

1. The opinion that airship development had not reached nearly such an advanced stage as that of aeroplanes. At first sight such a statement may appear open to doubt, as one connects up unconsciously the present dirigible with the old balloons which had such an ancient history, but as a matter of fact the dirigible and the aeroplane appeared side by side.

The great size and heavy cost of dirigibles and the large number of problems embraced in the design together with the astonishing amount of details requiring consideration, as stated by Mr. Green, have made progress much slower than in the case of the aeroplane.

I think, therefore, the lecturer is quite sound in his opinion and that we can anticipate great developments in the near future in the construction of airships.

2. The question of the highest speed which airships are likely to attain in the near future is, I am sure, of great interest to all of us, and I was much struck with the lecturer's views and with Lieut. Usborne's confident predictions of much higher speeds than obtained at present. I had the curiosity recently to read some of the opinions expressed some six or seven years ago on the subject, and one well-known authority gave it as his opinion that 25 miles per hour would not be exceeded in any airship; judging by analogy, therefore, one should not despair of obtaining a speed of something like 100 miles per hour in the next five or six years.

3. The statement that a new and much superior fabric for airships has been discovered and tried to a considerable extent, is clearly of very great importance, for it would seem to solve one of the principal difficulties.

4. Captain Waterlow described the improvements which have recently been made in the control of airships, especially as regards landing and mooring, and the advantages of swivelling propellers. Here, again, we have another of the chief difficulties connected with airships in the course of being overcome.

As one who for many years perhaps was more connected with sea service than land service, I may perhaps hazard the opinion that the ocean-going airship of the future will, as a rule, ride to moorings and comparatively seldom find it necessary to go into dock.

5. I entirely agree with Captain Waterlow that there is a great future for the commercial airships. Considering the rate of progress now being made, I anticipate that the realistic tour from London to Paris, described by the lecturer, will be quite common in a few years. Mr. Turner was doubtful of the effects of adverse winds of, say, 30 to 35 miles an hour, but with an airship speed of 70 miles an hour, the delays in such weather would not be so very great.

Perhaps it is too much to expect that manufacturers will launch out into the heavy expenditure necessary to initiate such a service without Government

assistance in some form or other—hence the energetic policy of the Admiralty in deciding to build large airships in this country assumes a new importance, for it is not only the defences of our country which will be benefited but also our commerce, not indirectly but directly, owing to improved means of transport.

I should like to add a few general remarks on the subject of airships and in doing so it is impossible to avoid altogether the comparison between airships and aeroplanes.

When endeavouring to look into the future it is clear that we should only be guided by the very broadest views, for flight is still very much in its infancy. It is not altogether a waste of time to read up past discussion on this subject even of several years past, to see what still holds good. I think it will be found that the forecasts of the most competent experts have been more consistent with the results since obtained than would be anticipated.

I doubt whether the basic considerations underlying the employment of airships and aeroplanes can be better expressed than they were in 1908 by Colonel Squier of the United States Army, who, by the way, made us an admirable speech here last May on the occasion of the Wilbur Wright lecture. Colonel Squier said, in a lecture delivered before the American Society of Mechanical Engineers, in 1908, "Euclid's familiar square cube theorem connecting the volumes and surfaces of similar figures, as is well known, operates in favour of increased size of dirigibles and limits the possible size of heavier-than-air machines in single units and with concentrated loads.

"It appears that both fundamental forms of aerial craft will likely be developed, and that the lighter-than-air type will be the burden-bearing machine of the future, whereas the heavier-than-air type will be limited to comparatively low tonnage, operating at relatively high velocity."

If I may venture to express any opinion in the presence of so many eminent designers and experts, I would like to draw attention to the increased employment of "planing" in the navigation of airships, either by taking advantage of the shape of the body or of the planes fixed to the body; and the greater the speed the more important does this become. I would ask, does not this suggest that in the future, particularly in the case of those enormous airships prophesied by Mr. O'Gorman, something of a compromise may result, the airship being largely dependent upon planes for its lifting power; it is even possible to imagine a slightly heavier-than-air airship with power of adding to its buoyancy on occasions.

We have not heard this evening as much as we should like perhaps of the naval views in airships, but there was a very excellent lecture given last year at the R.U.S.I. by Lieut. Boothby which brought the subject up to that date. We hope very much for the assistance of Naval Officers in the work of the Society, particularly now that the Admiralty have taken the control of airships under their charge.

Ladies and Gentlemen,—I am sure that you would all wish to pass a very hearty vote of thanks to Captain Waterlow for his most interesting and suggestive lecture. Captain Waterlow threw out a hint that this Society might utilise a portion of its energy and knowledge in replying to the many erroneous statements regarding flying which appear in the public Press. I scarcely think that we can undertake such a heavy burden, but the Society is only too glad when Naval and Military Officers come forward to tell us of the most recent developments in the work which they are carrying out so admirably and devotedly. The Society can then have these accounts discussed, as has been the case to-night, and the whole case can be published and circulated for the benefit not only of the Naval and Military Services, but also for the general good of Aeronautical Science.

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Captain WATERLOW, in replying to the discussion, said he must plead guilty to having understated the possibilities of airships, but he had feared that perhaps they would be unwilling to accept the truth.

So much has been said about swivelling propellers that he thought it should be made clear, once for all, that the Government obtained the idea from Mr. Beedle and actually bought the apparatus which he had constructed and used on his small airship.

In considering the question of aeroplane versus airship, it must be remembered that the airship's weapon has scarcely been thought of as yet.

There are many possibilities as yet untried. He would like to mention such things as vortex rings. The late Lieutenant Cammell some years back studied all the literature to be found in the British Museum and reported that vortex rings could be made from small mortars with an effective range of 1,000 yards or so, and capable of actually destroying wooden palings at 600 yards.

There were also possibilities in the use of chain shot, grape shot, canister, and other forms of old-fashioned short range projectiles. Most of these are heavy and need a heavy weapon to project them, and are therefore probably not practicable for an aeroplane.

An ideal defensive weapon for the airship has yet to be evolved. He fancied that it would be sufficiently potent to keep attacking aeroplanes at a respectful distance.

He would like, in conclusion, to thank the audience for their appreciation.

THE THIRD MEETING of the FORTY-NINTH SESSION of the Aëronautical Society of Great Britain was held at the Royal United Service Institution, Whitehall, S.W., on Wednesday, 17th December, 1913, at 8.30 p.m. The Right Honourable Lord Montagu of Beaulieu presided.

THE SCIENCE OF FAST FLYING.

BY C. T. WEYMANN.

In this lecture, which the Council of the Aeronautical Society, through Mr. Griffith Brewer, have done me the great honour to ask me to deliver before you, I propose to consider the rôle of *speed* or *fast flying* in aeroplanes.

As soon as aeroplanes were able to fly, the next preoccupation of designers was to make them fly as fast as possible. In order to stimulate constructors, Mr. James Gordon-Bennett created his International Aviation Cup, destined to consecrate every year the fastest flying machine. This contest, held yearly since 1909, will give us a valuable basis to examine the lessons which aviation has been able to draw from *pure speed*.

Reasons for seeking speed.

What are the reasons which led to the pursuit of speed in aeroplanes? First, practical reasons: The faster an aeroplane could fly, the larger would be the services it could render from the point of view of communication; because, in order to be acceptable as a means of conveyance either of mails or of passengers, or even of wares, it is necessary that, for a given distance, the aeroplane should be faster than the existing modes of communication, or cheaper, to make competition possible. *Cheaper?* This question would only draw a smile to-day; *faster?* This realisation is nearer to our present times.

Besides these reasons, there are some which are directly connected with the design and the construction of aeroplanes; and these we shall now examine.

Speed and Stability.

In the beginnings of aviation it was thought, not without a certain reason, that *speed* would be an element of stability in the air, and often one would compare an aeroplane with a kind of cannon-ball which "remous," eddies or whirlwinds, and "air-holes" would affect very little on account of its great momentum.

I must say that, even to-day, many are of this opinion, and we all have read articles praising speed as a sort of panacea or the sole means of security in aeroplanes. Therefore we will consider, in a general way, the relation which exists between the *flight* and the *speed* of an aeroplane.

Relation between speed and flight.

To be able to fly, an aeroplane must reach a certain speed at which its lift is equal to its weight; after which it can augment its speed if it possesses the necessary additional power, and this is what happens in practice.

Generally a machine, considered in horizontal flight, driven by its motor, possesses a certain "margin of speed"—it can fly at different speeds between a minimum and maximum. We perceive at once that this margin of speed can be

independent of the absolute value of the maximum and minimum speed ; in other words, we perfectly conceive a machine having a speed-range of 20 kilom. an hour —between 80 and 100 kilom. an hour for instance—and another machine having the same range between 180 and 200 kilom. an hour.

The "no-margin" Machine.

A machine whose maximum and minimum speeds are so near together as to become a single speed will be what is ordinarily called a machine "*tangent.*"* When it is said that an aeroplane loses its flying speed, what is meant is that the speed of this machine falls below the minimum speed requisite for its flight and that its lift is inferior to its weight.

Conditions governing fastest speed.

Let us now see under what conditions a machine may become the fastest possible. Suppose that a constructor has at his disposal only a motor of a given power. This constructor's interest is to make use of all his power solely from the point of view of speed and to take from this power just the portion actually indispensable to maintain the machine in the air. To do this, he will reduce as far as possible the head-resistance ("drag") of his machine ; he will give to his "fuselage" forms having the least air resistance ; he will reduce to the least needful all passive resistances such as wires, wire-strainers, struts, etc., of the landing chassis. He will do the same for the wings, their air resistance will be reduced as much as possible, keeping just the sustentation necessary for the machine to fly horizontally ; for it is evident that if it did ascend, the power used in making it rise would be lost for the speed of advancement.

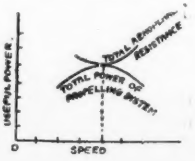
Now we find, in the wings with which we are acquainted so far, that the fraction showing the relation $\frac{Kx}{Ky} = \frac{\text{Resistance to advancement}}{\text{Sustentation}} = \frac{\text{Drag}}{\text{Litt}}$ is the best, that is, the smallest, for only one angle of incidence and that it augments or diminishes if we augment or diminish this angle of incidence. Therefore it follows that our interest is to make a machine flying at a certain well known angle in order to have the best utilisation of the power available.

Result of Fastest Speed.

As this angle is definite, the weight of the machine being also definite it follows that, for a certain speed, the area of the supporting surface is also definite—that is to say—if this surface is exactly what it must be, our aeroplane, having reached this certain speed on the ground (supposed to be perfectly even) will fly in indifferent equilibrium, or balance, without rising or descending, at the maximum speed which its resistance to advancement and the power of the motor will allow. It follows that this aeroplane will be the fastest which, in the present state of this science, can possibly be built with a given motor ; but this aeroplane will be a machine without margin of speed—"*tangent.*"

We find an immediate confirmation of what precedes, in considering what happened in the Gordon-Bennett contests.

* In English writings use has not been made so far of a literal translation of the French term "machine tangente." It may be derived directly from the fact that such a machine would always be touching the (level) ground from which it tried to rise, even when going its fastest ; or indirectly from the fact that if the curve of the motor power be plotted over the curve of the aerial resistance in the case of a "machine tangente," the two curves will touch at one point only, *tangentially.* The most suitable short equivalent of the term is, we suggest, "a 'no-margin' machine." ("A 'single-speed' or single angle machine" is liable to be misunderstood.)—Editor, "Aeronautical Journal."



Having finished a machine with a certain "fuselage" and a certain motor, constructors have always designed wings larger than was absolutely necessary, and this is easily understood on account of the almost insuperable difficulties of steering which, if built to the limiting condition, a machine would present. It follows that these machines flew under angles smaller than the "optimum" angle, and their head-resistance notably increased ; from this fact they flew less fast than they could have done with smaller wings ; and we have seen Bleriot in 1909, Leblanc and Hamel at Eastchurch, cut their wings at the last moment and gain in this way a few kilometres of speed. Therefore, the pursuit of *pure speed* in aeroplanes leads to the pursuit of a machine whose head-resistance is the smallest possible, and whose lift is the least possible superior to the weight of the machine —which means a machine "*tangent*," and consequently *dangerous*.

Dangers of "No-margin" machines.

Such machines are dangerous, for two reasons. First, by the fact that on the ground, while rolling, a "no-margin" machine reaches as much as possible its maximum speed, and consequently the landing is made at a sensibly similar speed. This is not without inconvenience when the ground is not perfectly even, and the pilot not sufficiently skilful to alight delicately, without his machine having any appreciable vertical speed at the moment of touching the ground.

The difficulties of starting, and chiefly of landing, have been so often the subject of many discussions that we need not devote much time to them here.

Rolling.

Everybody, in fact, can understand the difficulty of steering on the ground an instrument weighing 500 kil. rolling on two wheels, at a speed of 130 or 150 kil. an hour, without brakes and with a steering whose sensibility diminishes in proportion of the decrease of speed, so that, at about 60 or 80 kil. an hour, the machine goes exactly where it pleases—and then, if the pilot has not given it a strictly rectilinear direction when he could have done so, he has all chances to make a turn about on himself, which, I can assure you, offers very limited charms ! Needless to say that at such speeds it is impossible, without turning over, to try the least curve on the ground to avoid any obstacle.

But there is another cause of danger even as serious, if not more ; it concerns the flying qualities of the machine.

In the Air.

We have seen that to fly the fastest possible, the machine must be "*tangent.*" In consequence, this machine is at the very mercy of the least weakening of the engine, and "remous" can bring it into serious danger. In fact, when the motor weakens, the speed diminishes ; to keep up the speed and keep control of the machine, the pilot must steer it downwards, "dive," and land as soon as he can. If the motor stops entirely, one must immediately dive steeply in order to keep up the speed of the machine. All these manœuvres must be made rapidly, and the least inattention may lead to a catastrophe.

A Practical Example.

The Gordon-Bennett contest of 1911*, run in England, at Eastchurch, affords striking evidence of this. The English competitor, Hamel, having cut his wings in order to fly faster, and having, in fact, gained speed, found himself at a turn rounding a pylon, having lost a little of his speed and being rather near the ground. The aeroplane not being fully sustained, the pilot could not prevent it falling suddenly and coming into brutal contact with the ground. What might have been

* Won by the Author at a mean speed of 78 miles an hour.—Editor, "Aeronautical Journal."

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a fearful catastrophe was avoided, thanks to lucky circumstances. By the shock Hamel was projected forward, without touching any part of the machine, and he escaped with painful but not dangerous bruises. This machine, being "*tangent*," had no excess of power.

Effect of Gusts.

And this shows that we must not believe that *speed, pure and simple*, the maximum speed of the machine, is an element of stability. This is easily understood. If we take, for example, our extra fast and "no-margin" machine, it is certain that this machine will defend itself with difficulty against gusts of wind. For, to defend himself against, for instance, a lateral inclination, what has the pilot to do ? He must warp, or augment, the incidence of the wing which is lowering, and diminish the incidence of the wing which is rising. Now, in the case under consideration, these two manœuvres have for effect to augment the relation $\frac{Kx}{Ky}\frac{drag}{litt}$, therefore requiring a larger power than that which we have available. The speed, and consequently the lift, diminishes, the machine will not obey, and will accentuate its lateral movement.

The same for the "elevator" ; the only possible effect of moving it up or down is to make the machine "dive" ; one cannot make it rise.

The belief that a fast machine obeys better than a slow one comes solely from the fact that the machines of the Gordon-Bennett contests, with a few exceptions, were not quite "*tangent*," because, for practical reasons, their constructors could not reach that limit. These machines obeyed often better than ordinary aeroplanes, because they were simply "stock" machines fitted with a more powerful motor than ordinarily.

The fast machine is as sensible to whirlwinds as the slow machine ; but its momentum being greater, the shocks it receives are more violent but less prolonged.

Speed should come after Safety.

The progress in aeroplanes due to the Gordon-Bennett Cup is a progress in the construction, in the utilisation of materials and principally in the shapes of least head-resistance. But it can be well said that, to-day, the pursuit of *pure speed* is an antiquated formula because it is too incomplete. What, at present, must be looked for is an excess of power, which alone furnishes the necessary means of defence against "remous" and against the wind. Only after this comes speed, on the single ground of utility, so that the machine may in practice be able to fly in any direction, without too much interference, by the wind, with its range of action or with its speed.

To-day, now that aeroplanes have reached such improvements, there is too large a difference between a machine specially constructed for speed and an ordinary practical machine, to permit of the maintenance of the former old formula.

While we do homage to the different Gordon-Bennett Cup contests that have taught us not to fear speed, let us, while striving to fly very fast, the fastest we can, always keep in view the object of effective practical results and positive possibilities.

DISCUSSION.

Mr. ARCHIBALD R. LOW, in opening the discussion, said their guest of the evening, though politically a citizen of the United States, was in all that pertained to aviation a citizen of Paris, the centre of its development.

It was inspiring to find that a complete knowledge of the theory had in part gone to the making of one of the very finest practical pilots in the world.

For himself, for some years past he had striven to make known to British engineers and pilots some of the less known scientific work done in France in connection with aeronautics. It was no mere chance, no mere flash of genius, that brought the French to the leading position and kept them there, though the Wright Brothers had anticipated them in actually producing a machine that flew.

From the time of Pénaud in the seventies of last century down through a list of well-known names—Renard, Ferber, Soreau, Eiffel, to mention a few of the best known—the theory of the aeroplane had been developed systematically, and a body of sound doctrine had been created which had permeated, consciously or unconsciously, the whole industry in France.

Latterly he had noted that the Germans had turned their attention seriously to the technical side of aviation, and a very large number of workers were pursuing their researches in minute detail, and were accumulating a body of systematic results which, in the speaker's opinion, was bound to tell in the long run.

He had formed the opinion that, when the initial stages were passed—and they were rapidly passing—it was the Germans who would be our most formidable rivals in aeroplane development.

To give two single instances in which they had the advantage from the very start, in the design of framed structures, where high technical ability must be combined with long experience and sound judgment, it could not be questioned that German Engineers were far in advance of the rest of the world.

Then in the production of special materials—high-grade steel tube, for instance—it had been his own experience to scour England for a manufacturer willing to supply it at all, and he had been forced to accept 40 tons per square inch as the best which could be obtained in uniform quality and regular quantities.

In Germany, designers had spoken to him of 60 and 80 tons per square inch, and had mentioned prices not much different from what had to be paid here for 40 ton stuff.

British designers and manufacturers would appreciate the enormous significance of these few remarks. In this country he did not know where we should have been had not those in authority—he believed Lord Haldane was personally responsible—been very fortunate in their choice of those at the head of the National Physical Laboratory and its aerodynamical section, and of the Royal Aircraft Factory.

He would warn aeroplane constructors that only by organising their technical staffs on the same sound lines could they hope to conquer a share of the work at all commensurate with the heavy financial commitments they had made.

With regard to the technical discussion of the paper before them, he would ask permission to sketch on the black-board the way in which a machine became a no-margin machine as the surface of the wings was reduced, but would hand the detailed discussion to the Secretary for future study, rather than inflict heavy

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technical matter on the meeting. He hoped they would think that a fair compromise.

Mr. B. C. Hucks, in response to a request from the Chair for an expression of his views, said that as regards pure speed-flying he had little to say, but was much interested in the question of what was the maximum speed that any given machine could attain to if dropping vertically, as, for example, prior to looping the loop. He had the impression that his Bleriot reached its "terminal velocity" much quicker than the Morane-Saulnier; in fact, it seemed to him that the latter machine, being built for speed, was comparable to a piece of thick card dropping, as contrasted to his Bleriot, which might be likened to a piece of much thinner card or paper, the air resistance of which soon equalled the weight and checked further acceleration. He would like to know whether any of the technical experts present could tell him—he was purely a practical man himself—whether an easy way existed of ascertaining what were the respective "terminal velocities" of any two machines that might be compared.

By permission, Mr. Low made the following remarks in reply to Mr. Hucks's question:—An approximate rule for the maximum diving speed was to multiply the speed at the best gliding angle by the square root of the best gliding ratio.

The theoretical maximum speed might be rather higher, but would not be attained in the course of dives lasting as long as Pégoud's, and only if the machine were held dead true at the angle of least resistance.

E.g., if a Bleriot glides at 22 metres per second (about 50 miles per hour), with a gliding ratio of 1 in 5, the maximum speed in the dive is approximately $22\sqrt{5} = 22 \times 2\frac{1}{4}$, nearly $= 49\frac{1}{2}$ metres per second (111 m.p.h.). At the Army trials the Bristol monoplane glided at 28.5 metres per second (about 64 miles per hour), with a gliding ratio of 1:6.75; hence its maximum diving speed would be about $28.5 \times \sqrt{6.75} = 74$ metres per second (165 m.p.h.).

Apparently for looping and diving a comparatively slow speed and high head resistance are desirable, qualities the reverse of those usually aimed at.

Mr. W. L. Brock stated that any under-powered machines that he had flown were more of the school type than speed machines, but he was interested in what Mr. Hucks had said as to dropping vertically. He had tried this with a small Deperdussin machine and found it soon ceased to accelerate. This was in contrast to what Mr. Hawker had found on the Sopwith. He had dived, and had reached a speed so high that he thought it wise to straighten out without waiting to reach the terminal velocity.

He thought that every effort should be made to cut down head resistance, not necessarily for speed purposes, but to have power for climbing.

Mr. Gordon Bell said that one could distinguish two distinct types of speed machines now being developed; one was the type of the last Gordon-Bennett Race, a sort of projectile, and the other was the very large margin machine, such, for example, as the Avro and Sopwith. The second type was undoubtedly the best to encourage.

Mr. Griffith Brewer: Mr. Low gave a very valuable explanation of the meaning of the word "tangent" in connection with aeroplanes. I will try to give an illustration of the condition of flight of an aeroplane which is theoretically tangent.

Assume you have a tangent aeroplane trying to rise from the table. If I tilt the table up so as to force the machine to travel uphill, or even if I leave the table level, the tangent machine will not leave the table, but will travel on its wheels. If, however, I tilt the table down, even though it be only one

degree, then theoretically the machine will leave the table. In other words, a tangent machine cannot climb, because it uses all its power to fly horizontally.

Mr. Weymann has pointed to the most valuable consideration in fast flying when he says that, to be reasonably safe and useful, fast flying must also have an ample range of speed. The Gordon-Bennett Race, 1914, should bring out these qualities, because for machines to be eligible to fly in the race they must first show that they can fly at less than 70 km. per hour. Having shown that they can fly reasonably slowly, then they are permitted to race to see which machine can fly the fastest.

I should like to add a few words of my appreciation of Mr. Weymann. One of the qualities I so greatly admire in him is that of courage. It requires considerable courage to fly the fastest machine in the Gordon-Bennett Race. It also requires courage to fly out over a rough sea, such as I saw Mr. Weymann do at Monte Carlo last spring.

This Society can appreciate courage, because it undoubtedly possesses the same quality. It required a very considerable amount of courage to meet and solemnly discuss a subject which at that time was the laughing-stock of the scientific world. This the old members of the Society did, and I am proud to be amongst those old members. But the greatest deed of courage that even Mr. Weymann has done is that of coming over here and telling us that pure speed does not necessarily mean stability, and, for my part, I thank him most sincerely for doing us this great service.

Mr. W. MOORHOUSE, in response to a call from the Chair, said he had not flown for some months. What he was waiting for was a machine with so large a margin of speed that he could rise from and alight in his own garden with ease and safety.

Mr. T. W. K. CLARKE: As regards the question of ultimate speed when nose diving vertically, raised by Mr. Hucks, I can confirm what others have just said, and add that in particular for the B.E.2 Army machine the ultimate speed is about $2\frac{1}{4}$ times the normal speed, and, further, that the speed rises to within about 10 per cent. of this value in 4 seconds.

In connection with the subject of Mr. Weymann's extremely interesting paper, it occurred to me that it would be interesting to make a rough estimate of what possible maximum speed is obtainable under present conditions and with present knowledge.

To obtain this estimate, it is convenient to divide the whole resistance to straight flight, which, of course, has to be a maximum in order to give the maximum speed, into two parts:—

(1) That due to Surface Drag—*i.e.*, the Horizontal component of the pressure on the lifting surfaces.

(2) All other resistances.

Considering (1), we know that the vertical component of the pressures on the surfaces for any machine must equal the total weight of the machine, which we will suppose to be 1,000 lbs. in the case we are considering (the actual value is immaterial). Now, in any system of surfaces and for any particular angle of incidence the ratio of the Horizontal component, or Drag, of the pressures to the Vertical component (lift) is independent of speed at all high speeds—*i.e.*, the Surface drag is a certain fraction of the weight of the machine; this drag is then least when this ratio is a minimum.

From an examination of what are called the Lift and Drag Coefficients of various surfaces it would appear to be reasonable to take $\frac{1}{20}$ as the minimum

value for this ratio that may be expected in practice. In our case, then, this would make (1) the Surface Drag $= \frac{1}{20} \times 1{,}000$ lbs $= 50$ lbs. at all speeds.

Next consider (2), including all other resistances, viz. : body, wires, landing carriage, etc. By far the most important of these is the body; the size of this latter is generally determined, not so much by the size of the engine or lifting surfaces, etc., as by the size of the pilot whom it has to shelter; hence the body has a fairly constant size and resistance (at a given speed) over a wide range of engine power.

Judging from present-day examples, it will not, I think, be unreasonable,—for horse-powers up to, say, 200,—to take the whole value of (2) at 40 lbs. when the speed is 60 miles per hour.

Now, the resistances in (2) vary as the square of the speed, hence at any other speed these resistances will be $40\left(\frac{V}{60}\right)^2 = .011V^2$ lbs., V being in miles per hour. Hence the total minimum Resistance will be $50 + .011V^2$ and correspondingly the minimum shaft HP. $= (.13V + .00029V^3) \div .87$, [.87 being the efficiency of the propeller] $= .15V + .000033V^3$. We may now tabulate the power required to drive this 1,000 lb. machine at various speeds. I have at the same time tabulated the necessary wing area, this being obtained from the formula $W = kAV^2$, the value of k when the incidence is that which makes $\frac{\text{drag}}{\text{lift}}$ a minimum (about 3° to $3\frac{1}{2}$° at high speeds) being taken as .0008 when A is in square feet and V in feet per second.

SPEED LIMIT TABLE FOR A MACHINE OF 1,000 LBS. WEIGHT AND OF A SIZE TO JUST CARRY THE PILOT.

V Miles per hour.	Horse Power due to			Area $= \frac{5.8 \times 10^5}{V^2}$
	Surface Drag $= .15\ V.$	Body etc. Resistance $= .000033\ V^3.$	Total.	
50	7·5	4	11.5	232 sq. ft.
100	15	33	48	58 ,, ,,
150	22	112	134	26 ,, ,,
175	26	178	204	19 ,, ,,
200	30	267	297	14 ,, ,,
250	39	520	557	9 ,, ,,

From the above we see that

(1) The body resistances at high speeds swamp the Surface Drag, and therefore so long as the body is kept a constant size the weight of the machine does not matter much. For example, if we take the case V = 200 miles per hour a 5 per cent. increase in the weight would only increase the HP. by 1.5—*i.e.*, .5 per cent.

(2) The table shows how very fast the area diminishes with the speed. At 150 miles per hour, for instance, the HP. is 134 and the area only 26 square feet; with such a small area available the difficulties of control would be very great, but we will imagine them to have been overcome.

(3) Although the table has been carried up to over 500 HP. on the supposition that the body, etc., resistance coefficient remains constant and is determined by the size of the pilot to be sheltered, yet it is plain that as the HP. increases there will come a time when the size of the engine becomes the determining factor. We may expect this to happen at about 200 HP. corresponding to 175 miles per hour. After this the size of the body may reasonably be taken to be proportional to the size of the engine, and its resistance therefore to the square of the linear dimensions of the engine. Calling the length of the engine, say, "l," then Body resistance $\propto l^2V^2$ but the volume and weight of the engine $\propto l^3$ and the speed of rotation is determined so that the centrifugal and other stresses do not exceed a certain limit—*i.e.*, $\frac{\text{mass.} \times r \times \omega^2}{\text{area}} = \text{const.}$

whence $l^2\omega^2 = \text{const.}$

i.e., $\omega \propto \frac{1}{l}$

From consideration of the engine

$$\begin{aligned} \text{Power} &\propto \text{Volume} \times \omega \\ &\propto l^3 \times \frac{1}{l} \\ &\propto l^2 \end{aligned}$$

Also from consideration of the propeller

$$\begin{aligned} \text{Power} &\propto \text{Thrust} \times V. \\ &\propto \text{Resistance} \times V. \\ &\propto l^2 \times V^2 \times V. \end{aligned}$$

Combining these results $l^2 \propto l^2 \times V^3$.

The inference from this is that when the engine attains such a size that the whole resistance of the machine is determined by it, then the limit of speed will have been reached.

If the size of the engine is the determining factor for the body, but has not yet reached such a size that $\omega \propto \frac{l}{r}$, but if, for instance, ω is keeping fairly constant with the increased size, then it is easily seen that we shall have

$$\text{HP.} \propto l^3$$

and $l \propto V^3$.

therefore HP. $\propto V^9$, a rate which very soon gives the limit to V. Hence it would appear that with present knowledge *175 miles per hour is roughly the limit to flying speed.*

Let us consider the form that such a machine would take. The body would be of fair size, while the wing area would be very small, about 19 or 20 square feet, the propeller of about 4 feet diameter, the landing gear reduced to a minimum and probably of skid form; starting and landing would probably only be possible on large stretches of smooth ice. The whole machine would resemble a finned torpedo.

THE CHAIRMAN said that he was sure that all present felt much indebted to Mr. Weymann for his kindness in coming over and reading his most interesting paper. He had, himself, taken much interest in speed, firstly of motor-cars and motor-boats, and latterly of aircraft.

He had, some years ago, made many observations of birds flying in the Solent between two points a mile apart, and had gained some interesting data regarding the relation between weight, wing area, and speed. (See annexed notes kindly furnished by Lord Montagu.—EDITOR.) He had discussed his observations with Wilbur Wright when he first came to Europe, and had found a substantial agreement between them and the data Mr. Wright had concerning aeroplanes.

He thought that, as regards the use of aircraft for commercial passenger and goods traffic, evolution would lead to a combination of the dirigible and the aeroplane as the most useful craft.

He was interested in Mr. Low's remarks as to the competition of other nations in the race for aerial supremacy. We had started late, but there was no doubt that we were undoubtedly making up our leeway very fast, if we had not in fact already done so.

It was sometimes said that already aeroplanes had attained unprecedented speeds, but it was interesting to reflect that the motor-car had still to be beaten. Recently one had attained to 146 miles an hour, while the fastest aeroplanes at present had done only about 130 miles an hour.

He wished to express the thanks of the meeting to Mr. Weymann for his most interesting paper. (Applause.)

GENERAL RUCK said that the Society was much indebted to Lord Montagu of Beaulieu for his kindness in taking the chair, and he was sure that those present would show their appreciation in the usual way. (Applause.)

The meeting then terminated.

NOTES ON THE FLYING OF BIRDS AND BEETLES.

BY LORD MONTAGU OF BEAULIEU.

For many years I was able to observe with considerable accuracy the speed of birds between two points on the flat seashore opposite my house in Hampshire. As it happened, there was a post and a point just about a mile apart, and as my house was situated approximately half-way between these two marks, I was able to time the birds on calm days and also with and against the wind.

The general conclusions I arrived at were that very few birds flew at speeds exceeding fifty miles an hour, the fastest birds that I timed (in order) being (1) cormorants, (2) swans, (3) ducks, (4) dunlins, and (5) knots. Birds that are commonly supposed to fly fast, like sea-gulls, etc., never attained anything like the speed of these other birds.

The general conclusion that I came to—a conclusion arrived at by deduction—was this, that the smaller the wing area of the bird compared with its weight, the faster the bird had to fly to maintain itself in the air.

To take another example at the other end of the scale, the owl, which has a very large wing area for the weight and size of its body, flies exceedingly slowly and is not capable of any speed.

It will also be noticed that all birds that fly fast have pointed tips to their wings, and that their wing tips when flying are in a position some way back from the head and the centre of gravity. The cormorant, for instance, which is a very fast flying bird, has a long neck, but comparatively small wings, and yet a heavy body. The heron, on the other hand, flies comparatively slowly, though it has a long neck, but it curves its neck when flying, and in addition has large wings of a curved nature and a much larger wing area in proportion to its weight than the cormorant. There are many other instances of this.

Now, as regards insects. The stag beetle, and, in fact, the majority of

beetles, are more closely allied to the aeroplane, whether monoplane or aeroplane, than any bird. The dragon-fly is also specially typical of the monoplane, for, though it has two sets of wings, four wings in all, the hinder set of wings are set in the same plane as its forward set of wings. But the beetle is wonderfully similar to the aeroplane in that its curved wing casings are used solely for lifting purposes when in flight, while the true wings under the casings propel. In most beetles there is no power of movement in the wing casings at all, and these casings are very much like the wing of a modern aeroplane, only rather more deeply curved.

I am convinced that a good deal of interesting information could be obtained from the more careful study, not only of the flight of birds, but the flight of insects, the latter in some ways being much nearer the aeroplane than the bird.

AIR-SPEED INDICATORS.

No instrument yet devised by man is incapable of improvement—faults may be found in all of them. All that is required, however, in order to make the best use of these admittedly imperfect tools is simply to know where the faults lie and how to make adequate allowance for them. If we can do this we can get results as near the truth as is necessary for most uses. In the case of air-speed indicators it may be a question of life or death to the pilot whether he knows, firstly, what faults the speed indicator has that is fitted to his machine, and, secondly, how he should act on the incorrect information it gives on certain occasions. It would be interesting to know how many of the pilots who use speed indicators are clear on both the above points. Probably not many. Now the reason for this may be, either that the designers have not themselves a complete grasp of the theory of their instruments, or that they have not communicated to the pilots a clear statement of the faults to be looked for. In any case a grave responsibility rests on all concerned to do their utmost to show the pilot how he may safely use the instruments. For that reason communications such as that printed below are of great value. The designers of air speed indicators who already knew what Mr. Booth so clearly demonstrates, cannot object to its being made clearer to pilots than apparently it has been made up till now, while those who did not know will be, of course, grateful for having it pointed out.

If they have not already done so, designers will, it is to be hoped, now hasten to tell the pilot how to interpret the readings given by the instruments they have designed; the pilot for his part would be well advised to make a most careful note of any erratic behaviour of instruments he is using and give the designers no rest till they have remedied the cause or told him how to make allowance for the error.

It will be seen that in Mr. Booth's communication the "f" of the indicator and of the aeroplane are both measured from the same spot, the centre of gravity of the aeroplane. It is obvious that if the speed indicator gauge is not at the centre of gravity of the aeroplane a vertical motion will be given to the gauge, independently of any vertical motion of the aeroplane, whenever the latter alters its attitude. Numerically worked out, the resulting gauge error may not be serious; the question should, however, be carefully examined.—EDITOR.

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THE THEORY OF THE GRAVITY-CONTROLLED AIR SPEED INDICATOR AS APPLIED TO DYNAMIC LIFT FLYING MACHINES.

BY HARRIS BOOTH, A.M.INST.C.E., A.F.AË.S.

As far as the writer is aware, Mr. Horace Darwin was the first to call attention to the fact that there is an essential difference in action between a spring-controlled and a gravity-controlled air speed indicator on an aeroplane.

This fact was put forward in the Wilbur Wright lecture of last year and the conclusion then reached was definitely in favour of the use of the gravity type, as being more useful to a pilot on a steeply banked turn.

Since that date, however, the discovery has been made that this type fails to give warning of "stalling" in straight flight (the very purpose for which the instrument is installed) and equally fails under the conditions of a banked turn.

The writer believes that he has the priority in this discovery, and therefore takes the present opportunity of publishing the following formal proof of the scientific theorem involved.

Whether an air speed indicator is of the pitot tube class or of the pressure plate class the force on it due to relative wind velocity varies as v^2, where v is the relative velocity.

If now the controlling mechanism of the air speed indicator depends on the action of gravity, it necessarily depends on the numerical value of relative or apparent gravity as measured in the aeroplane.

It is clear that in a gravity-controlled air speed indicator of any type the equation of equilibrium of the gauge relative to the aeroplane is

$$v^2 = (g - f) \times (\text{a function of the position of the indicator}) \qquad (1)$$

where g is the acceleration due to gravity and f is the vertical component of acceleration of the aeroplane relative to earth, measured positive when downwards.

Turning now to the aerodynamic law by the operation of which the aeroplane is supported, we know that the lift exerted on the aeroplane by the air forces is a function of the attitude of the machine multiplied by v^2. If therefore M is the mass of the machine, the equation of motion relative to the earth is

$$M\,g - \text{lift} = M\,f$$
$$\text{or } M\,(g - f) = v^2 \times (\text{a function of the attitude}) \qquad (2)$$

On multiplying this equation and (1) together we have

$$(\text{a function of the attitude}) \times (\text{a function of the indicator position}) = \text{a constant independent of } v \text{ and of } f. \qquad (3)$$

Solving this equation formally for the indicator position we have

$$(\text{the position of the indicator}) = (\text{a function of the attitude of the machine, independent of } v \text{ and of } f). \qquad (4)$$

This equation is equivalent to the following statement:—

The indication given by any gravity-controlled air speed indicator on an aeroplane is sensitive to the attitude of the machine, but not to the velocity of the machine or to its vertical acceleration.

The practical importance of the theorem just proved lies in the fact that an air speed indicator is fitted to an aeroplane in order that the pilot may be warned when he is approaching the limiting supporting speed, below which the machine must inevitably start dropping; hence, if a pilot relies on a gravity-controlled instrument he goes in constant danger of stalling his machine, the consequences of which are too well known to require repeating.

In the above proof use has been made of the conception of relativity of force. This is an idea which, although unquestionably sound, is not very widely known. A modified form of proof is therefore added here, which avoids the employment of relativity, though at the cost of some elaboration in the demonstration.

A Further Proof.

It will simplify matters to confine our attention to the consideration of an instrument of which the pressure gauge portion consists of a column of liquid in a U tube, the exposed limb of which is of area a and the other limb or limbs of combined area A; the consequent loss of generality in the demonstration is not very serious since this is actually the only type of gravity-controlled instrument at present in use.

Let ρ be the density of the fluid employed in the gauge.

Then if the aeroplane is falling with an acceleration f and travelling forwards at the same time with a velocity v relative to the air, the difference of pressure on the two limbs of the U tube is λv^2, when λ is a constant.

Let d be the height by which the liquid in the gauge stands above the zero position, and D the corresponding height for the concealed limb (then D is of course negative).

Let p be the pressure in the fluid at height n above the zero (in either limb) and consider the forces on an element of the fluid between the heights n and $n + dn$.

In the visible limb the volume of the element is $a\ dn$, its mass is $\rho\ a\ dn$, $\therefore$ the attraction of gravity on it (*i.e.*, its weight) is $\rho\ g\ a\ dn$.

The only other forces acting on it in the vertical direction are $a\ p$ upwards and $a\ (p + dp)$ downwards, which reduce to a single force $a\ dp$ downwards (dp is of course actually negative). This element of liquid also shares in the general vertical acceleration of the aeroplane.

We have now worked out the mass, the acceleration, and the forces acting on this element, all in the vertical direction, and are therefore in a position to write down its vertical equation of motion, namely,

$$a\ dp + \rho\ g\ a\ dn = \rho\ a\ f\ dn$$

$$\text{whence } \frac{dp}{dn} = -\rho\ (g - f)$$

$\therefore$ on integrating

$$p = -\rho\ (g - f)\ n + \text{a constant of integration.}$$

Now at the top of the visible column, $n = d$, therefore the pressure at this point $= -\rho\ (g - f)\ d +$ constant; similarly the pressure at the free surface in the concealed limb or limbs is $-\rho\ (g - f)\ D +$ the same constant.

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Therefore the difference of pressure which is balancing the aerodynamical pressure difference is $-\rho\ (g - f)\ (D - d)$, whence we have the equation

$$\lambda\ v^2 = -\rho\ (g - f)\ (D - d) \qquad (1)$$

Now let us find out what is the velocity which the pilot would read off on the scale under the above circumstances, *i.e.*, what velocity corresponds to a reading d.

The instrument, of course, was calibrated on a fixed support, *i.e.*, under the conditions $f = o$.

Therefore if v_1 is the velocity which gave the reading d (with D in the other limb) when the instrument was calibrated, we have the equation

$$\lambda\ v_1^2 = -\rho\ g\ (D - d) \qquad (2)$$

from this and equation (1) we get

$$v_1^2 = \frac{g}{g - f}\ v^2 \qquad (3)$$

where it will be understood v is the velocity of the machine, but v_1 is the velocity shown on the gauge.

Now consider the vertical equation of motion of the aeroplane as a whole. Let M be its mass and L the lift. Then $L = \mu\ v^2$ when μ is some constant.

The vertically downward force on the aeroplane is $M\ g - L$, therefore the equation of motion is

$$M\ g - L = M\ f$$
$$\text{or } M\ (g - f) = L = \mu\ v^2 \qquad (4)$$

Now supposing that on some other occasion the aeroplane was flying in the same attitude but at its correct supporting speed, let the velocity be then v_2. Under these circumstances $f = o$, therefore equation (4) gives

$$M\ g = \mu\ v_2^2 \qquad (5)$$

from which and equation (4) we get

$$v_2^2 = \frac{g}{g - f}\ v^2 \qquad (6)$$

Comparing this equation with equation (3) we see that

$$v_1 = v_2 \qquad (7)$$

This equation is equivalent to the following statement:—

The velocity read on the gauge when the machine is really underspeeded and consequently falling with an acceleration is not the actual velocity at that time, but is the velocity which would suffice to keep the machine up—if it had it.

This will be recognised as being equivalent to the conclusion reached in the shorter proof by the first method.

SUPPLEMENTARY NOTES ON DRZEWIECKI'S THEORY OF AIRSCREWS.

By Archibald R. Low, M.A., Associate Fellow.

In the previous contribution and in the reply to the discussion justice was not done to several points.

It was made clear that a circulation of air was established round the airscrew at standstill, creating a certain velocity before the airscrew disc in such a way as to modify fundamentally the thrust on the blades. But it was not explicitly stated that at full speed (of the aeroplane) this component of velocity was ignored altogether and each blade was assumed to be attacking "still" air.

This does not mean that the air was still until the blade actually drew level with it, for, if the analogy with lifting surfaces holds, we know that at a distance of twice the chord width in front of the blade the air is appreciably disturbed, and this disturbance may be by no means negligible even at four or five times the chord's width in front of the instantaneous position of the blade.

But it does mean that with respect to air, say, ten blade widths ahead of the airscrew boss, the air is not sensibly in motion.

Soreau, in his book, devotes much space to the "régime préalable" of the air, and holds that such circulation does exist and reduces the possible airscrew efficiency in the ratio of 9 to 10 approximately.

For normal aeroplane speeds, at least, the present writer is unable to accept this effect without experimental evidence.

Several years of constant observation of airscrews and lifting surfaces in action have convinced him that such velocities are almost insensible at three or four times the chord in front of the disturbing surface.

It is certain, however, that any theory of airscrews which follows the whole range of phenomena from zero torque to standstill must first ascertain what relation the velocity of circulation bears to the aeroplane velocity.

If such a relation were obtained as an empirical equation there seems no reason why an approximate formal solution should not be obtained for the whole range.

With regard to priority, Soreau places Drzewiecki's original paper on marine screws in 1882, which gives him 16 years priority over Lanchester's "Aerodynamics."

In discussing definitions of pitch Soreau holds substantially the same point of view as the writer.

He points out that there are three possible aerodynamical definitions of pitch:—

(1) Pitch of zero thrust;

(2) Pitch of zero torque;

and more correctly

(3) Pitch of zero "average" reaction normal to blade path.

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Referring to the notation of the paper

$$\text{Thrust HP} = \frac{2\pi}{75 \text{ a.m.}} \frac{V^5}{\omega^2} \left\{ I_1 - I_2 \right\}$$

$$\text{Torque HP} = \frac{2\pi}{75 \text{ a.m.}} \frac{V^5}{\omega^2} \left\{ I_1 + I_3 \right\}$$

The definition (1) which is Mr. Bramwell's "Experimental Mean Pitch" implies that $I_1 - I_2 = O$.

(2) Implies that $I_1 + I_3 = O$.

(3) Is defined by $I_1 = O$ and obviously lies between (1) and (2) if I_1, I_2, I_3 are positive quantities, as they must be if the analogy with lifting surfaces hold even qualitatively.

Soreau infers from Eiffel's tests (2nd edition, p. 226), as the writer inferred from Riabouchinsky's that the ratio $V \div n$ for which the torque is zero is an *increasing* function of n.

Now quite apart from the special assumptions of the writer in the previous notes, and from the special forms of I_1, I_2 in the case of the "Normale" and "Rational" propellers, it is certain that there exist physical conditions which may be expressed in analogous form, provided only that each element of the blade does have a reaction with the air and that this reaction is resolved into two components normal and tangential to the path of the blade element.

Hence the equations
$$\begin{cases} \text{Thrust HP} = C \dfrac{V^5}{\omega^2} (I_1 - I_2) \\ \text{Torque HP} = C^1 \dfrac{V^5}{\omega^2} (I_1 + I_3) \end{cases}$$
(where C may be assumed nearly equal to C^1 from experimental results) are perfectly general and independent of any particular hypotheses, so that the above arguments as to the aerodynamical definitions of pitch are also perfectly general.

I_1 I_2 I_3 are here to be considered undetermined functions of $\frac{V}{n}$ and of n which vary slowly with n when $\frac{V}{n}$ is constant.

Another rather important point which was very scantily treated is the value of "m" $1 < m < 3$.

The writer has since found airscrews for which $m = 3.5$, so that $1 < m < 4$ is a better rule, drawn from practice merely.

With regard to the rule $1 < m < 3$ the lower limit is based on the analogy with biplanes. Eiffel's experiments indicate that interference is sensible when the chord equals the gap, and increases rapidly as the ratio of gap to chord decreases below unity.

This ratio is analogous to m.

The upper limit 3 is based on the consideration that the chord may be increased and the radius reduced in such a way that $c \times r^3$ is constant provided there is no sensible interference.

Hence, increasing c by 30% we may reduce r nearly 10%, with increase of efficiency, in most cases, if the theory is even roughly correct.

Actually airscrews are put on the market with values of m running up to 3.5 or 4.

In the formula for the "Normale" airscrew constant chord $= \frac{\pi V}{m \omega}$, m has a slightly different significance which should have been denoted by accenting the m or otherwise. Doing so now to distinguish m^1 of the Normale formulæ from m of the Rational formulæ, we have in the example given

$$m^1 = \frac{\pi \times 13}{56.5 \times .216} = 3.33.$$

whereas m is variable as shown by the following table:—

r	0	.25	.50	.75	1.00	1.32
m	0	2.47	3.06	3.18	3.26	3.30

Thus m^1 is the limiting value of m when r becomes very great and when cos β becomes nearly $1 \div \tan \beta$. The quantity m^1 was really only introduced to show the close relation between the Rational and Normale Formulæ, which is masked when we write c for $\pi V \div m^1 \omega$.

With regard to interference of blades the only instructive experiments with which the writer is acquainted are those of Riabouchinsky (Bulletin de Koutchino II).

From Fig. 21 we get, for an airscrew experimented with, the following values near the blade tip:—

$$\tan (\beta - i) = 4.1.$$

From the three figures in 22, we get for the velocity of the air *before* the airscrew, and therefore for β and i

Turns per sec.	V	$\omega \times 1$ metre radius.	$\tan \beta = \frac{\omega r}{V}$	β	i
100	1.25	10.4	8.3	83.0°	7°
200	2.25	21	9.4	84°	8°
300	3.5	31.4	9.0	83.5°	7.5°

Hence the angle of attack at standstill is about 7.5° for a blade whose chord pitch at the tip (and in this case along the whole blade) is given by $\tan (\beta - i) = 4.1$.

Turning to figures 40, 41, 42, we get a series of thrust measurements for 1, 2, 3 ... up to 13 equal blades in the form of sectors of 18° angle.

At the tip $(\tan \beta - i) = 4$.

Assuming i to be as before 7.5° we get the following table for m against the number of blades "a" and the thrust coefficient α.

No. of blades.	Coeff. of thrust.			% falling off from proportionality.
a	α	m	$m \times \alpha$	
1	.66	2.2	1.45	0
2	1.24	1.1	1.36	6
3	1.72	.73	1.26	13
4	2.15	.55	1.18	19
5	2.42	.44	1.06	27

The falling off of $m \times \alpha$ is a measure of the interference.

It is seen that for $m = 1$ the falling off is sensible, namely, 6%, for $m = 1.1$, and increases rapidly as m decreases.

Hence the rule $1 < m$ seems to have reasonable foundation in experiment.

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CORRESPONDENCE.

To the Editor.

SIR,—Kindly print the following "errata" in "Notes on Drzewiecki's Theory of Airscrews" in the last issue of THE AËRONAUTICAL JOURNAL.

In the Normale formulæ m should be m^1 throughout to emphasise the fact that it is a slightly different quantity from the m of the Rational formulæ.

p. 220, line 8, insert the factor r on the right hand side.
line 11, insert the factor V on the left hand side.
p. 222, line 1, for K''_N K''_N read K''_N K'''_T.
p. 229, line 28, for K'''_N read K''_N.
p. 233, line 7, for 76.7 read 70.7.
line 11, for 74.9 read 68.9.
lines 13 and 16, for 103 read 97.
line 14, read $\eta = \frac{68.9}{97} = 71$.
p. 233, line 17, read Torque h.p. = 10.6 efficiency 71.

The mistake in arithmetic was pointed out by Mr. A. Graham Clark, Technical Editor of "Flight." It arose from a badly formed nought in the manuscript, the error being unnoticed by the writer when checking the proof, and no independent check of the arithmetic being applied.

The corrections make the approximation of the theory to Eiffel's tests more remarkable, especially as Drzewiecki himself predicted a torque h.p. of 10 from coefficients obtained from his practice. The loss calculated by taking the boss as equal to a rectangle .02 metres square with a coefficient of resistance .08 is nearly .05 h.p., about $\frac{1}{2}\%$ reducing the efficiency to $70\frac{1}{2}\%$.

The writer has no method of estimating the tip losses and losses caused by the reaction of the air on the mounting.

A. R. LOW.

LIST OF BRITISH FATALITIES.

Date—1914.	Name.	Nationality.	Machine.	Place.
Jan. 26.	G. Lee Temple	English	Bleriot (1)	Hendon.
Jan. 27.	L. Gipps (P.)	English	Bristol (1)	Lark Hill.

(1). Monoplane. (P.) Passenger.

NEW BOOKS AND PUBLICATIONS.

Flugzeug-Modelbau. Bigenwald. Berlin: Richard Carl Schmidt, 1914. pp. 171. Illus.

Leitfaden der drahtlosen Telegraphie fur die Luftfahrt. Max Dieckmann. Berlin: R. Oldenbourg. 1913. pp. X+. 214 illus. 8 M.

Das Naturgesetz des freien Schwebens der Vogel. F. H. C. Mordhorst. Kiel: Lipsius und Tischer. 1913. pp. 15.

Langley Memorial Proceedings. Washington: Smithsonian Institution. 1913. pp. 21.

The Powers and Aeronautics. London: John Murray. 1913. pp. 88. 1s.

Das Fliegen. P. Bejeuhr. Berlin: Klasing and Co. 1914. pp. 32. Illus. 60 Pfg.

Aero Manuel, 1914. Ch. Faroux et G. Bonnet. Paris: Dunod et Pinat. 1914. pp. 868. Illus.

Principles of Flight. (2nd Edition.) A. E. Berriman. London: Office of "Flight." 1913. pp. 45. Figs. 2s.

REVIEWS

Essais d'Aérodynamique (Troisiéme Serie). By Armand de Gramont, Duc de Guiche. (Paris: Librairie Hachette et Cie. 1913. pp. 145. Illus.)

The present publication gives the results of tests carried out on flat plates in the open air; the plane, on which the experiments were to be performed, was mounted above a motor car and the pressures at various points on the surface transmitted to a number of water **U** tubes enclosed in a camera. The readings of these gauges were then registered simultaneously on a photographic plate.

The open ends of the **U** tubes communicated with the interior of the camera, and the author's proof (p. 25) that the pressure inside the camera is that of the free atmosphere is somewhat unconvincing; it is possible, however, that this is merely due to insufficient particulars being given. In any case, if this pressure is not atmospheric, it is only the ratio of the pressures on the front and back faces that is wrong and not their sum.

In the first place the effect of varying the span of the plane, the breadth being kept constant, was determined; and the author arrives at the conclusion that, if the span is great enough, the effect of the ends on the medium section is negligible. The actual value of the span required, before this is so, is open to question, as there must have been considerable disturbance at the ends of the planes, due to the method of mounting that was employed. Calculations were then made of the values of the total pressure on the two faces by two methods:—

(1) The total pressures were integrated from the pressure readings obtained over the whole plane.

(2) The total pressure was determined on the assumption that the pressure on the median line obtained over the whole plane. The agreement obtained was fairly close, so that in the further tests the pressure along the median line only was determined. Some further tests were then made with planes of constant span but varying breadth; the final result arrived at, from a consideration of all the tests, for the total force being:—

$$P = 0.050 (\sin i)^{0.4} S l^{-0.25} v^2$$

where P is the force in kilogrammes, S the area in sq. metres, v the speed in metres per second, l the breadth of the plane in metres, and i the angle of incidence.

This is only true if the plane is large enough for $\frac{\text{L, the perimeter}}{\text{S, the area}}$ to be negligible in comparison with 35, and also only applies for values of i between 0° and 20°.

A third series of tests was made on three planes in tandem, the surfaces under test all lying in one plane. The distances between the surfaces were made respectively 0, 5 and 10 cms. Under these circumstances the pressure distribution along the median line may be considered as being a compromise between what it would be for one complete plane, and for three separate planes, the proportion being varied with the gap.

No tests have so far been made on curved surfaces, but the author states that such are in hand.

A point of very fundamental importance has been left to the end of this review; the author devotes an appendix to an endeavour to show that experi-

ments carried out in a wind channel are not comparable with those made by moving the surface through still air. It may be stated here that it is a fundamental law of mechanics that the conditions are identical if a surface is moved uniformly through still air and if it is exposed to a uniform current of air of the same velocity. Discrepancies are liable to appear if the air current is not uniform, and, more important still, if the surface is too large for the air channel, so that the effect of the walls is appreciable. It is to be hoped that these large scale experiments will be continued, especially with some typical aeroplane wings; these will have to be smaller than full scale to keep the aspect ratio constant, as the largest plane that has so far been tested is only 1.8 metres span.

The accumulation of experimental data on a large scale is necessarily slower than for models, so that the more experimenters in the field the quicker the advancement of aeronautical knowledge.

F. H. B.

L'Aéronautique Navale. By Chas. Lafon. (Paris: Dunod and Pinat. 1914. Illus. pp. 255. 7 francs.)

As a specimen of the machine-made book, M. Chas. Lafon's effort is not easily equalled. We get the same familiar sledge-hammer chapters and the equally familiar, astonishingly erroneous remarks on foreign organisation. The author's information about the state of aeronautics in this country seems to have been provided by a practical joker. With some difficulty we refrain from making further comments.

Aviation. By A. E. Berriman. (London: Methuen. 1913. Illus. pp. 360. 10s. 6d. n.)

Mr. Berriman has written a book that it is hard to classify. It is not a purely technical book, and it is not, strictly speaking, a popular book. At the same time, it is readable and fundamentally sound; anybody going carefully through the book should possess a very fair knowledge of the subject when he has reached the last page. The author fails in reaching the ideal merely because he is human. No one man can write a satisfactory book on aviation. The collaboration of ten specialists might do it, but even this is doubtful. In the work under notice, we get bold unsupported statements, such as, "It is the upper side that contributes most to the lifting effect of the wing in flight" (p. 25); and curious attitudes of mind that produce the following dicta on stability: "In the absolute sense, longitudinal stability would imply that the fore-and-aft axis of the machine was never disturbed from an attitude parallel to the horizon." As a whole, "Aviation" appears to be a painstaking, conscientious piece of work, such as one would expect from its author, who is well known as an enthusiastic student of the science.

H.

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